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CONTENTS

The Influence of Set upon Association and Thought. FLOYD H. ALLPORT 159

Attitudes of Children . . . . . KARL M. DALLENBACH 183

Cereb[illegible] . . . . . HERBERT A. TOOPS AND RUDOLF PINTNER 231

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THE INFLUENCE OF THE GROUP UPON ASSOCIATION AND THOUGHT

BY FLOYD H. ALLPORT

Harvard University

INTRODUCTION

If social psychology is to achieve the title of an independent science, it is high time that its many speculative theories and crude generalizations be subjected to experimental methods. The data of this science, it appears to the writer, may be for convenience subsumed under two heads, viz.: (1) the behavior of an individual in direct response to social stimulus, that is in response to some form of behavior in others, and, (2) behavior which is the response to a non-social stimulus, *e.g.*, a column of figures to be added, or a meal to be eaten, when such response is modified by the presence and actions of other persons. Responses to direct and incidental social stimuli are, in brief, the two classes of data for social psychology.

The following experiments bear upon certain problems of the second class of data mentioned. The method employed was to compare the mental processes (in this case association and thought) of the individual when alone with his reactions to similar and equivalent stimuli when a member of a "co-working or co-feeling" group. In this manner the part played by incidental or contributory social stimulation was determined.[1]

[1] A brief historical account of the study of the influence of the group upon the individual may be found in an article by W. H. Burnham: 'The Group as a Stimulus to Mental Activity,' *Science*, N.S., 1910, Vol. 31, 761–767.

General Method.—It was considered advisable to eliminate all incentives to rivalry which were not inherent in the very nature of the situation (*i.e.*, individuals working on similar tasks in one another's presence). The subjects were instructed not to regard their work as competitive; overt comparisons between individuals were also prohibited. The time given for the tests was constant, hence no one subject finished before the others. In this way rivalry, which is a distinct social problem and which should be studied separately, was reduced to its natural minimum. Each subject, however, was instructed to acquire the attitude of doing his best in both the group and the solitary work.

The subjects were arranged in groups, containing from 3 to 5 subjects each. The groups had no changes of personnel during a whole experiment. The subjects were upper classmen and graduate students in psychology at Harvard and Radcliffe Colleges. They were 26 in number, though not more than 15 were used in any single experiment. There were 24 men and 2 women. In age they ranged from 20 to 40 years, 26 being the average age.

In the group work the subjects were seated one on each side of a table 3 feet by 5 feet in dimensions. In groups of 5 two subjects sat at one of the longer sides. The same seats were retained by subjects throughout the course of an experiment. Care was taken to secure conditions, such as type of table, light, air, seating of the subjects, etc., in the rooms used for solitary work comparable to those conditions in the room where the subjects worked as a group.

The free chain associations which were to be written were started by a stimulus word, for example 'building' or 'laboratory,' written at the top of a sheet of paper given to each subject. The same stimulus words were employed in the two conditions, *T* and *A*.[1] It was also emphasized in group work that the same stimulus word was given to all. It is not believed that the presence of the experimenter in the group work materially affected the results of the social influence.

In all experiments except the first constant intervals of

[1] *I.e.*, 'Together' and 'Alone.'

time were given, in the group by spoken signal, and alone by buzzers placed in each room and tuned down to inobtrusive intensity. Control tests were given in the group, using the buzzer for signals in order to determine whether the buzzer itself played a part in the results. No difference was found in the average, between group tests given by the buzzer and those given by verbal signal. The writing materials (pen, pencil, etc.) used by each subject were kept as constant as possible throughout the experiment.

Experiment I

Free Chain Association

1. *Procedure.*—The first experiment, introductory in character, was the only one in which the amount of work was constant, and the time required to finish was taken as the objective result for each subject. Sheets of paper were ruled for writing 100 words. Three tests were given within the hour. Only one group, consisting of but 3 subjects, was used for the experiment. The experimental hour came once per week, and the experiment lasted about 12 weeks. There were weekly alternations of the social conditions, together (*T*) and alone (*A*).

The papers were placed before the subjects face down. At the signal they were reversed and the subjects glanced at the word given at the top and proceeded to write their free associations one below the other. The writing of the successive words of sentences or phrases was prohibited as was also the serial association of numbers. While working together the time for each subject was taken by the experimenter; when working alone each subject timed himself with a watch or stopwatch. A rest of three minutes was given between test sheets. Immediately after the completion of each test, both together and alone, the subject was required to mark with distinguishing symbols certain kinds of ideas, as follows: (1) *Personal associations* (ego-centric), that is, words related directly and intimately with the subject's own past as experience not likely to play the same part in another's association trends; and (2) words which were written without

discoverable connection with any of the preceding words, that is, 'free-rising ideas.'

Treatment of Data.—In the following pages the term 'social increment' is used to indicate a gain in the average quantity of work done in the group over the average done alone. 'Social decrement' indicates a loss in quantity in the group performance. Corresponding gains and losses in *quality* of the work in the group are termed 'social supervaluents' and 'social subvaluents' respectively. The social increments, decrements, super- and subvaluents, are always expressed as a percentage of the average quantity or quality of the work done alone.) In this experiment the individual social increments or decrements are given on the right in Table I.

The results expressing the social influence upon the kind of associations (personal, objective, etc.) were too meager to admit conclusions. They are therefore omitted for this first experiment.

TABLE I

AVERAGE TIME SCORE FOR 100 WORDS

(No. of trials for each individual: Alone 9, Together 12)

Subject	Alone	Together		
Bar.	4.3	3.9	Gain together	9.3%
Stu.	5.8	5.0	Gain together	13.8%
Lan.	3.3	3.4	Gain alone	3.0%
Average	4.4	4.1		

3. *Discussion of Results.*—Two out of three subjects have a social increment. Both of these increments were much greater than the social decrement of the other subject. For the group there was an average gain in time over solitary work of three tenths of a minute. The first rough indications therefore point toward an increased number of free associations produced in the group.

EXPERIMENT II

Free Chain Association

1. *Procedure.*—The study of free associations under the social influence was now continued using a larger number of subjects and tests. The groups used all came twice within a

week, the experiment lasting three weeks. There were 15 subjects arranged in 3 groups of 5 subjects each. It was decided to use fairly frequent alternations of the conditions *T* and *A*, thus equalizing effects of practice. One group (*C*) underwent alternations of "together" and "alone" *on the same day:* sometimes two and sometimes four alternations. A combination was used of the sequences *T A T A* (or *A T A T*) and *A A T T*. If the tests of a certain day began with *T* and ended with *A*, those of the following day would begin with *A* and end with *T*. The entire series moreover began with *T* and ended with *A*. Hence the initial lowering due to newness of the task and the final possible increase due to practice would favorably affect only the score for work done *alone*. The other two groups (*A* and *B*) changed their social condition on successive days. Group *A* began with a day in *T* and ended the series with *A*; group *B*, as a check, began the series with *A* and ended with *T*.

The routine of this experiment had one important difference from that of the preceding. The *time* was now the constant factor, and the *number of words written* was the measure of the association process. The interval of each test was three minutes, given with a suitable preparatory interval, by voice in the groups, and by buzzer when the subjects worked alone in separate rooms. A short rest period was allowed between tests.

Another important variation was the division of the work of each test into three *periods* of *one minute each*. After one minute of the time had elapsed the experimenter (in the groups) directed "draw line," whereupon each subject quickly made a line under the word he was then writing or had just written, and then continued with his work. This was repeated at the expiration of the second minute. When the subjects worked alone these signals for the divisions were given by short strokes of the buzzer. The rooms of the subjects when working alone were interchanged from day to day in order to obviate the effect of the peculiarities of any one room upon the work of a subject.

To the two types of associations required to be marked in experiment I. were added two more, viz: (1) words, other

than the first, suggested mainly by the stimulus word; and (2) words suggested by the immediate surroundings. Introspection was required immediately after each test together with a rough estimation of the degree of the rivalry consciousness expressed on a scale of 0 to IV. In all other respects not mentioned the procedure was the same as that in experiment I.

2. *Treatment of Data.*—The individual tables are omitted because of lack of space. Table II. presents the individual averages. Practice effects at the beginning which appeared in the individual records have been eliminated from the averages by the following rule. In the first day's work (group *A* and *B*) all tests which are lower than every single score made in tests on later days are ruled out.

TABLE II

INDIVIDUAL AVERAGES OF ASSOCIATIONS

Subject	No. Trials[1]		Alone				Together			
			No. Asso. per Min.			Total No. Assoc.	No. Assoc. per Min.			Total No. Assoc.
	A	*T*	1st. Min.	2d. Min.	3d. Min.		1st. Min.	2d. Min.	3d. Min.	
And.	13	15	18.3	18.3	19.3	56.	20.5	18.7	19.	58.3
App.	11	10	21.5	20.8	20.3	62.7	23.6	20.2	19.6	63.4
Cut.	5	6	23.8	22.4	21.6	67.8	28.1	25.8	24.6	78.7
Hor.	11	10	19.3	18.2	16.6	54.3	20.3	16.9	17.2	54.4
Hos.	6	6	15.1	14.1	13.5	44.2	16.5	15.6	16.1	48.3
Hun.	13	16	18.7	18.9	19.	56.8	19.8	16.8	18.4	55.1
Kno.	14	15	18.7	18.5	20.	57.3	20.	20.4	17.6	58.2
Lan.	13	15	19.3	18.8	18.9	56.8	20.2	20.2	20.7	61.2
Pep.	13	12	24.2	21.9	22.2	68.4	24.2	23.5	23.5	71.2
Pre.	14	16	24.9	22.2	22.7	69.9	26.4	23.7	22.2	72.4
Rob.	12	13	22.	21.6	21.3	65.	24.1	24.3	24.6	73.
Spe.	14	15	22.3	19.2	25.7	67.4	22.2	23.	22.2	67.5
Sto.	14	16	15.2	12.5	12.3	40.1	16.5	15.	15.1	46.5
Tul.	13	12	27.5	25.	24.3	76.9	28.2	26.8	25.7	80.9
Woo.	5	10	21.8	20.6	19.	61.4	22.8	21.4	21.5	65.7
Average ..	11.4	13.5	20.8	19.5	19.8	60.3	22.2	20.8	20.5	63.6

3. *Discussion of Results.* (*a*) *Quantity of Associations.*—Table III. presents the average number of associations, together and alone, for each subject, together with the per cent. of gain under the social condition to which it belongs. We find our first experiment amply verified. 93 per cent.

[1] Exclusive of the trials eliminated owing to effect of practice.

of the subjects (14 out of 15) produce more associations in the group than they produce alone. The social increments are not large, but their preponderance is conclusive. Cut, Rob, and Sto have considerable social increments (from 12 per cent. to 16 per cent.). The average social increment also of the 14 is twice as great as the social decrement in the case of the one exception to the favorable group influence, Hun. The number of associations produced by all subjects together is also slightly greater than their average alone (63.6 to 60.3).

TABLE III

PERCENTILE GAINS IN AVERAGE NUMBER OF ASSOCIATIONS

Subject	Ave. No. Associations		Per Cent. of Gain	
	Alone	Together	Alone	Together
And	56.	58.3		4.1
App	62.7	63.4		1.1
Cut	67.8	78.7		16.
Hor	54.3	54.4		.2
Hos	44.8	48.3		7.8
Hun	56.8	55.1	3.	
Kno	57.3	58.2		1.5
Lan	56.8	61.2		7.8
Pep	68.4	71.2		4.
Pre	69.9	72.4		3.7
Rob	65.	73.		12.3
Spe	67.4	67.5		.1
Sto	40.1	46.7		16.4
Tul	76.9	80.9		5.2
Woo	61.4	65.7		7.
Average	60.3	63.6	3.	6.2
Mean variation	7.6	8.5	—	4.1

Number of subjects having higher average number of associations together..... 14
Number of subjects having higher average number of associations alone..... 1
Number of subjects having equal average number of associations together and alone 0

The mean variation among the subjects is higher, relatively to its mean, in group work than in solitary (8.5 compared with 7.6). Hence we find increased variability accompanying a social influence toward increased mental activity.

Let us now consider the *distribution of the social increment.* The question proposed is whether the increase due to the presence of the group was equally distributed, or whether it occurred chiefly at the beginning, the middle, or the end of the three-minute period. The record of each subject in the

three minutes is shown in Table II. We may compare the results of the three-minute periods both in number of subjects who have social increments in those minutes respectively, and also in the percentile value of the gain in group work shown in the average of all subjects in the three minutes respectively. This latter comparison is taken from the averages at the foot of Table II. We may speak of this gain as the 'group social increment.' Table IV. presents the above relations.

TABLE IV

	1st. Min.	2d. Min.	3d. Min.
No. of subjects having greater number of associations *together*..	13	12	9
No. of subjects having greater number of associations *alone* ...	1	3	6
No. of subjects having equal number of associations *T* and *A* .	1	0	0
Group Social Increment { Amount of excess of Together over Alone....	1.4	1.3	.7
Group Social Increment { Per cent. of excess of Together over Alone....	6.7	6.6	3.5

In both proportion of subjects having a social increment and in the amount of the increment itself, we thus find that the superiority of the group condition in speed of associations exists throughout the test, but is greatest in the first minute and least in the third minute. The second minute is not far below the level of the first, the drop in increase due to the social influence coming well toward the end of the task.

If we compare the three one-minute periods with each other in the two social conditions separately (Table II.) we find the following. The averages of all subjects alone (20.8, 19.5, and 19.8) indicate a drop in the second minute, followed by a slight rise (probably an end spurt) in the last minute. The averages together, on the other hand, (22.2, 20.8, and 20.5) form a steady decrease to the end. This result suggests that the effect of the group is at first a stimulating and later a steadying one.

Another possible interpretation seems to be that during the first minute when the associations come with great facility, the social influence counts for a relatively greater addition of speed than toward the end of the test when, through fatigue and comparative exhaustion of complexes and vocabulary, the facility of writing associations has de-

creased. Under difficult conditions therefore being alone tends to favor concentration. Group work on the other hand contributes no such benefit to the final and more difficult stages of the task.

(*b*) *Quality of Associations.*—The four general types of association, mentioned under procedure, were counted in each individual test. The average number of each type per test for each subject, in group and solitary work separately, is given in Table V.

TABLE V

AVERAGE NUMBER ASSOCIATIONS OF VARIOUS TYPES

Subject	Alone				Together			
	Personal	Free Rising	Sugg. by Stim. Word	Sugg. by Surround-ings	Personal	Free Rising	Sugg. by Stim. Word	Sugg by Surround-ings
And.....	8.9	.3	1.9	3.1	2.8	.4	.2	2
App.....	17.8	.4	.1	5.9	24	.4	.4	8.7
Cut.....	20.2	.8	0	0	17.1	2.6	0	0
Hor.....	48.3	.7	.3	1.2	47.7	1.3	1.4	6.8
Hos.....	19.5	.8	1.3	0	13	.6	.5	0
Hun.....	11	1.2	2.7	.3	11.5	1.6	1.5	3.4
Kno.....	1.9	3.4	0	2.4	1.3	2	0	1.7
Lan.....	16.2	.8	.8	2.2	12.8	.5	.7	1.5
Pep.....	19.5	4.5	.4	4.7	15.2	2.8	.3	12.5
Pre.....	7.2	0	1.6	0	7	.1	.9	1.7
Rob.....	45.5	.1	.2	1.5	43.9	.7	.3	4
Spe.....	2.1	0	0	0	2	.1	0	.3
Sto.....	18.5	.1	.1	0	27.3	0	.1	0
Tul.....	15.6	1.1	.2	1.6	12.4	1	0	1.2
Woo.....	11.4	1	.3	1.1	10.1	1.2	1.5	0
Average.	11.4	1.1	.6	1.6	16.5	1.2	.5	2.9
M. V....	8.1	.8	.6	1.3	10.3	.9	.4	2.7

	No. Subjects Having Greater No. Alone	No. Subjects Having Greater No. Together	No. Having Equal No. Alone and Together
Personal Assoc.....	12	3	0
Free rising assoc.....	5	9	1
Assoc. Sugg. by Stim. Word....	7	4	4
Assoc. Sugg. by Surroundings ..	5	7	3

The first type, and the one yielding the clearest result, is that of *personal* associations. 80 per cent. (12 out of 15) of all the subjects wrote down more personal associations *alone* than together. There is evidently some sort of attitude assumed by the individual in the group which takes him 'out

of himself' and directs his ideas toward outside objects, and as we shall show later, to the actual presence of the others. In the group we are inclined to expand in our thought; we become objective rather than egocentric, present rather than retrospective.

Secondly, *words suggested by the immediate surroundings* appear to be more numerous in the group than in the solitary condition. If we consider the average of all subjects, the tendency is marked, for the average together is almost twice as great as that alone (2.9 to 1.6). Individuals considered, we find that 3 show no tendency either way while 7 produce more words relating to the surroundings in the group, and 5 produce more alone. Hence we find that an environment of active persons is more likely to intrude upon one's trend of thought than an environment of mere space and furniture such as in the solitary condition.

The third type of associations, the 'free-rising' ideas, also occur more frequently in the group. The averages give only a slight increase for the group work; but the individual records show that 64 per cent. (9 out of 14) of persons affected either way produce more of these spontaneous ideas in the group than they do alone. It is possible that 'free-rising' words result here from that greatly facilitated flow of associations characteristic of work in the group.

Finally, we may note that *words*, other than the first, *suggested mainly by the stimulus word* are more numerous in the solitary than in the group condition, as shown by the average of the individuals and especially by the number of individual cases (ratio of 7 to 4). The explanation, though obscure, may lie in the longer persistence of the original trend of thought in the solitary than in the social setting.

(*c*) *Correlations.*—There are, finally, several correlations to be described. The first is that between the rank of individuals in speed of association and their rank in regard to the favorableness of the group influence on their work. We find, in harmony with the results of other investigators, and with the writer's own study of attention and mental work, that there is an inverse correlation—though here it is a very small

one (− .12).[1] Important exceptions act to reduce the index of correlation: for example, Cut is high in both respects; Hor is low.

A further correlation was developed to indicate to what extent the social increments were due to that irreducible minimum of conscious rivalry characteristic of all co-working. It was found that only 3 subjects experienced no rivalry at all. The remainder, 13, all recorded on the average of all tests more rivalry in the group than alone. The ratio of this increase was 1.9 to 1. The correlation between this excess of rivalry consciousness 'together" and the size of the social increment was found to be so slight as to be negligible. It was .23. There was also no correlation (.02) between the subject's report of mere vividness of consciousness of the group (or its absence) and the amount of the stimulation to speed afforded by the group.

(*d*) *Introspection.*—There was substantial evidence from the introspection of awareness of being "*drawn out*" by the presence of the group, so as to produce associations of a more objective type, as previously shown in the results. As to the group influence on speed, two clear cut factors appear in some cases in the same report. The first is an *impeding* influence owing to sensory distraction, emotional factors such as over-stimulation in rivalry, self-prejudicial comparisons with others, and the like. The second and stronger factor is *facilitation.* Numerous stimuli indicative of the rapid work of one's neighbors serve as a drive to greater effort. The principle here involved is probably that commonly known as "suggestion" or "imitation" in superficial accounts of group and crowd phenomena.

Experiment III

Free Chain Association

1. *Procedure.*—The method used in Experiment II. was considered imperfect on the following ground. Associations

[1] All correlations in this paper were obtained by the use of the rank method, using the formula:

$$r = \frac{6\Sigma(d^2)}{n(n^2 - 1)}.$$

are as a rule produced more rapidly than they can be written, and therefore the writing down of each one in turn does not allow the most rapid play of which the process is capable. The results may measure, not the associational ability itself, but simply the speed of writing. A short experiment was accordingly prepared in which the subject was to write down, not *every* word, but every *fourth* word which occurred to him. With a little practice the subjects rendered automatic the rhythm of writing every *fourth* word only. The division of the three minute period into 3 parts was not made in this experiment. The subjects and grouping were the same as for experiment II. The tests were presented on two days, within the period of a week. The sequences of alternation were as follows, the horizontal line dividing the work of the two days:

Groups *A* and *C*	Group *B*
T	*A*
T	*A*
A	*T*
A	*T*
T	*A*
A	*T*
———	———
A	*T*
A	*T*
T	*A*
T	*A*
A	*T*
T	*A*

2. *Treatment of Data.*—The number of associations written in each test was multiplied by 4 and tabulated. The record of Tul is omitted owing to insufficiency of data. The result of the first test was eliminated whenever it was found to be lower than the score of any succeeding test under the same social condition. Table VI. presents the usual summary of individual records.

3. *Discussion of Results.*—The results shown in Table VI. indicate again a distinct though less pronounced advantage for work done in the group. Two subjects show a social equivalence. Of the rest 66 per cent. produce more associations in the group. The group average for the associations together is greater than the average alone, and the average of

the social *increments* is very much greater than the average of the social decrements.

TABLE VI

COMPARISON OF AVERAGE NUMBER OF ASSOCIATIONS. (ALSO PERCENTILE GAINS)

Subject	No. of Trials		Av. No. Associations		Per Cent. of Gain	
	A.	*T*	Alone	Together	Alone	Together
And.	5	6	130	130	—	—
App.	6	5	150	158	—	5.3
Cut.	6	5	166	163	1.8	—
Hor.	6	6	113	117	—	3.5
Hos.	6	6	80	85	—	6.2
Hun.	5	6	82	82	—	—
Kno.	6	6	89	101	—	13.4
Lan.	6	6	117	125	—	6.8
Pep.	6	6	113	111	1.7	—
Pre.	6	6	119	126	—	5.9
Rob.	4	6	121	118	2.4	—
Spe.	5	6	126	129	—	2.4
Sto.	6	6	54	60	—	11.1
Woo.	4	5	120	119	.9	—
Average.	5.5	5.7	112.8	116	1.7	6.8
M. V.			21	20.1	.4	2.7

Number of subjects having greater number of associations *Together*. 8
Number of subjects having greater number of associations *Alone*. 4
Number of subjects having equal number *Together* and *Alone*. 2

The number of trials was too small to allow the mean variation to carry much significance. Comparing however the mean variation of the social increments with that of the decrements, we find distinctly more variability in the former. In other words the social influence, when it affects workers favorably, affects them also in very varying degrees. Considering, not increments, but actual number of associations written together and alone, the variability both relatively and absolutely is greater alone.

The correlation between the individual's ability to associate rapidly and the size of his social increment is still inverse, and somewhat greater than usual ($-.53$).

The consciousness of rivalry was in most cases slight in amount, and occurred in slightly over half the individuals. The effect on the work however was perhaps noticeable. Between excess of rivalry together and the size of the social increment there was the small correlation of .41.

Experiment IV

Free Chain Association

1. *Procedure.*—Since the conclusions of experiment III. were based on rather few results the experiment was repeated using fewer subjects but about twice as many tests. This time no stimulus word was given: the subject thought of his own initial word. Another difference was that every *third* word, instead of every *fourth*, was written. The subjects numbered eight and were divided into two groups of 4 each. The experiment covered about five weeks, each group being tested once per week. There was an average of four tests in each hour that the groups were tested. The sequence of social conditions employed a combination of alternations in successive days and alternations within the same day. Group *A* began with *T*, and group *B* with *A*. (In tabulating the number of words set down was the actual number of associations *written*. The individual summaries are presented in Table VII.)

Table VII

Comparison of Average Number of Associations. (Also Percentile Gains)

Subject	No. Trials		Average No. Associations		Percent of Gain	
	A	*T*	Alone	Together	Alone	Together
Aza	9	9	25.5	27.5		7.8
Cur	8	10	18.6	19.6		5.3
Han	5	4	35	37		5.7
Ric	9	15	24.9	22.8	8.4	
Rot	8	16	16.9	17.3		2.3
Sli	9	10	19	20		5
Tan	8	16	29	29.6		2
Tay	7	9	47.1	42.8	9.1	
Average	8	11	27	27	8.7	4.7
M. V.			8.2	7.1	.35	1.7

Number of subjects having greater number of associations *Together* 6
Number of subjects having greater number of associations *Alone* 2
Number of subjects having equal number of associations *Together* and *Alone* 0

3. *Discussion of Results.*—The general results of this experiment verify those of the one preceding. A somewhat greater proportion of subjects (75 per cent.) have a social increment. This proportion is still, however, less than the

93 per cent. who attained social increments in the mechanical task of writing down *every* associated word.

The average increment is less than the average decrement owing to the unusually large decrements of the two subjects who did better alone. This fact probably justifies the conclusion of individual differences, the two subjects, Ric and Tay, requiring the solitary condition for their best efforts. Work upon reasoning (see Exp. VI.) corroborates this tendency in the case of Ric.

The mean variation agrees with that of experiment III. in showing a greater variability in work done alone. (The mean variation of increments and decrements is here without value owing to the small number of cases.) We should take into account here the part played by rivalry in producing the social increment of the results. The correlation in this experiment is very high (vide infra). Where rivalry is effective (*i.e.*, not merely present) in group work there is a tendency toward uniformity among the members.

The correlation between the subject's associative ability and the degree to which his work is increased by the group is still inverse, though small ($-.19$). Here also we find toward the extremes conspicuous exceptions to the inverse correlation.

We noted in our last experiment a slight tendency for conscious rivalry to become a cause, or at least an accompaniment, of the group stimulus. We now find that tendency verified. There was found a positive correlation of .89 between the excess of consciousness of rivalry together and the size of the social increment. Rivalry therefore plays a greater part in the speed of associations for the most part merely *thought* than it does in the case of associations whose flow is limited to the speed of their *writing*. This result is doubtless due in part to the readier improvability of the mental association speed than of the speed of writing.

The significance of inhibitions in producing the solitary decrement is suggested by a positive correlation between an excess of inhibitions alone and the tendency to improve in the group. The correlation found (.76) indicates that the low

level of the subject's work alone is connected with his inhibitions—these inhibitions occurring for him more numerously in the solitary than in the group condition. Alone there is evidently a blocking, traceable perhaps to a lapse of attention or effort, or to forgetting "where one is." Under the stimulus of the group the response receives greater facilitation.

Experiment V

Controlled Association—Contrasted Occupations

As a minor digression from the usual setting of the experiments, an attempt was made to compare not the work of the subject alone with his work in the group, but to compare his accomplishment, always in the group, in tasks *similar* with that in tasks *opposite* to the occupations of his fellows. Half of the group were seated at one side of the table and instructed to write words all bearing upon one specified topic (*e.g.*, winter), while the other half, seated opposite, wrote words all bearing on the opposite theme (summer). The solitary condition was not used in this experiment.

A test pair consisted of two performances upon a given theme, one the result of working in the manner described above, the other produced at another time when all members of the group wrote upon the *same* topic. Only about three such test pairs were obtained from each subject. Their total for the experiment was 35. Of these pairs 19 showed an excess of associations written in the common occupation over those written in contrasted work. In only 16 pairs was the advantage with the contrasted occupation. The average excess also in the common work was greater (7) than the average excess where it occurred in the contrasted setting (5).

So far as these results go there seems to be an advantage in tasks in which all are working in agreement over work done while pursuing diverse trends of thought. The tests given are however too meager for certainty; they indicate merely an interesting possibility for further investigation.

Experiment VI

Thought Process

1. *Procedure.*—An experiment was finally performed which extended the study of the social influence to the more intellectual functions involved in reasoning. Statements have been made by various writers that this "higher" quality of process is better performed in solitude. Tests of critical and original thinking were therefore devised in the nature of discursive reasoning. Short passages were selected from the works of Epictetus and Marcus Aurelius which admitted of considerable argument, for and against. The task of the subjects was to write down all the arguments, as many and as strong as possible, which they could think of to *disprove* the point made in the passage given. The epigrams both together and alone were presented in legible handwritten form, one copy to each subject. At the beginning of the group tests it was emphasized that they were all writing on the same statement. The time allowed for writing the ideas in a single test was 5 minutes. A separate passage was used for each test.

Nine subjects were used, arranged in two groups, *A* and *B*. Approximately 20 tests were given alone and 20 in the group. The total period covered by the experiment was 2 months. The social condition was changed (from *A* to *T*, or from *T* to *A*) on successive days. Group *A* began with *T*, group *B* with *A*. The passages selected naturally varied somewhat in suggestiveness; but it is believed that in a series of 20 a fair uniformity was obtained for the two social conditions. This is still more likely since only two authors were used, and those two are singularly constant in the tenor of their utterances.

2. *Treatment of Data.*—Each test written was graded as to quality of the arguments proving the negative of the statement. For this purpose the following scale was used. A distinct, clear, and (for the subject) forceful idea going directly to the question received a score of 3. Developments, extensive illustrations of the point made, giving pertinent

opinion of an authority, refining or re-stating the question to remove its logical objections, suggesting an alternative proposition, and the like, each counted 2. Emphatic statements or interjections of rejection, quotations merely stating the opposite, personal aphorisms, repetition of an argument already given, qualification or withdrawal or a former argument, rather irrelevant arguments, and so on, were each scored 1. For each subject each type of idea or argument thus contributed its proper score to each test; and by averaging the sums of these scores for the various tests there were found the average individual scores for ideas. These results are presented in Table VIII.

TABLE VIII

REASONING

Average Scores for Ideas

Subject	No. Trials		Score of Ideas		Per Cent. of Gain	
	A.	*T.*	Alone	Together	Alone	Together
Aza	19	22	5.6	6.6		18
Cur	19	16	7.5	7.6		1.3
Han	15	24	12.6	14		11
Ric	23	19	9.7	9.7		
Rot	17	20	4.5	4.8		6.6
Sli	19	20	9	10.2		13.3
Tan	23	19	7.7	8.2		6.5
Tay	2	5	9	10.2		13.3
Wil	12	15	7	8.4		20
Average	16.6	17.7	8	8.8		11.2
M. V.			1.7	1.9		4.9

Number of subjects having higher idea score *together* 8
Number of subjects having higher idea score *alone* 0
Number of subjects having equal idea scores *together* and *alone* 1

In addition, the total number of ideas of the three types, together and alone, found in the work of each subject, were averaged separately. Table IX. presents this comparison of averages of ideas types. Taking the number of each type as a per cent. of the total number of ideas in the given social condition (*i.e.*, together or alone), one may compare the relative contributions, together and alone, of the several types to the total idea score for the subject. This comparison is shown in Table X. Finally the words written in each test

were counted, and the average number of words per test for the different individuals, together and alone, was computed. Table XI. contains these averages together with the percentile gains under the proper social condition.

TABLE IX

AVERAGE NUMBERS OF IDEA TYPES

Subject	Average Numbers per Test of the Various Types: 3's, 2's and 1's[1]					
	Alone			Together		
	3's	2's	1's	3's	2's	1's
Aza	1.3	.6	.3	1.5	.9	.2
Cur	1.5	1.3	.3	1.6	1	.6
Han	3.2	1.2	.3	3.5	1.4	.6
Ric	2.3	1.1	.3	2.2	1.3	.4
Rot	1	.5	.6	1.2	.4	.4
Sli	1.9	1.5	.1	2.5	1.2	.3
Tan	2.4	.1	.0	2.6	.1	.05
Tay	2.5	.5	.5	2	2	.2
Wil	1.7	.7	.4	1.8	1.2	.6
Average	1.97	.8	.31	2.1	1.0	.36

TABLE X

PERCENTILE COMPARISON OF IDEA TYPES

Subject	Per Cent. of Average Total Ideas Comprised by Ideas of the Various Types—3's, 2's, 1's					
	Alone			Together		
	3's	2's	1's	3's	2's	1's
Aza	59	27	14	58	34	8
Cur	48	42	10	50	31	19
Han	68	26	6	64	25	11
Ric	62	30	8	57	33	10
Rot	48	24	28	60	20	20
Sli	54	43	3	63	30	7
Tan	96	4	0	94	4	2
Tay	72	14	14	48	48	4
Wil	61	25	14	50	33	17
Average	63	26	11	60	29	11

[1] These figures are *numbers* of cases only. The idea scores, as given in Table VIII., were obtained by multiplying the number of 3's by 3, the 2's by 2, and the 1's by 1. and then adding these products. This was done in the separate tests however, since the averages given in Table IX. contain small inaccuracies due to decimals.

COMPARISON OF PERCENTAGES

Type 3	Number of subjects having higher percentage for type 3 together	3
	Number of subjects having higher percentage for type 3 alone	6
Type 2	Number of subjects having higher percentage for type 2 together	4
	Number of subjects having higher percentage for type 2 alone. (1 subj. equal)	4
Type 1	Number of subjects having higher percentage for type 1 together	6
	Number of subjects having higher percentage for type 1 alone	3

TABLE XI

AVERAGE SCORES FOR WORDS WRITTEN

Subject	Score of Words		Per Cent. of Gain	
	Alone	Together	Alone	Together
Aza	69	90.4		31
Cur	81.4	80.9	.6	
Han	148	144.1	2.6	
Ric	98.4	108		9.7
Rot	29.8	39.6		33
Sli	119.7	125.6		4.9
Tan	58.6	67.5		15.1
Tay	158	167.8		6.2
Wil	100.4	96.2	4.1	
Average	96	102	2.6	16.6
M. V.	32.1	30.3	1.1	10.2

Number of subjects having higher word scores together 6
Number of subjects having higher word scores alone 3
Number of subjects having equal word scores together and alone 0

3. *Discussion of Results.*—From Table VIII. it will be seen that of the 9 subjects used, 1 had equal average idea scores together and alone. The remaining 8 *all* had higher idea scores when working in the group. The average idea score together for all subjects showed also a social increment: it was 8.8, while the average alone was 8. The individual social increment, generally rather large, ranged from 1.3 per cent. to 20 per cent., 5 out of 9 being above 10 per cent.

Turning to the percentile importance of each idea type alone as compared with its importance together, as shown in Table X., we find that 6 out of 9 subjects had a higher percentage of superior ideas (counting 3) while working alone. The number of the subjects, together and alone, having the higher percentage of "2" ideas was *equal.* There were (reciprocally to the "3" class) just 6 out of 9 subjects who

had a higher percentage of the lowest type of ideas (counting 1) while working in the group. The averages of all subjects indicate also a higher performance, relatively, so far at least as the proportion of superior ideas is concerned, while working alone. There is thus demonstrated a social subvaluent for argumentative or discursive reasoning. This finding is no doubt in accord with commonly observed facts of life. Who has not been aware, upon retrospection, of the low order of logical value in many arguments given under such a strong social influence as that of political meetings and oral debates? There seems to be a *spreading out* of our throught rather than a strong output of separate original ideas of logical worth. Group thought is *extensive*; individual thought is, to some extent, *intensive*.

May not this "extension" in group thought be also characterized as "wordiness"? It seems quite logical to call it this, for Table XI. shows that 6 out of 9 subjects wrote more words in the group than they did alone. The averages of the individuals' scores also show the group gain in number of words written (102 to 96). A third evidence lies in the excess in the average of the social increments (16.6) over the decrements (2.6). This disclosure is consistent with the results of all previous experimentation on the social influence. There has been throughout a clear increase of the *quantitative* aspect of mental processes and mental work in the group condition. Our association experiment of writing every word in free thought may be compared with the writing of every word in controlled thought in the present experiment. In both cases every subject but one showed, in the quantity of words written, a distinct social increment.

4. *Introspection.*—There is some evidence in the reports of the awareness of the social subvaluent in the thought process.

SUMMARY OF CONCLUSIONS

A. The Influence of the Group upon Association

I. *Quantitative Aspects*

1. The main result of the preceding experiments on association is the conclusion that the *presence of a co-working*

group is distinctly favorable to the speed of the process of free association. In various tests from 66 per cent. to 93 per cent. of the subjects show this beneficial influence of the group.

2. The beneficial group influence is *subject to variation according to the nature of the task.* In the more mechanical and motor requirements, such as writing *each word* associated, the group stimulus is more effective than in the more highly mental or more purely associational tasks such as writing only every *third* or *fourth* word.

3. There are *individual differences* in susceptibility to the influence of the group upon association. One type, who are nervous and excitable, may succumb to the distracting elements of the group activity and may show either no effect, or else a social decrement.

4. *In its temporal distribution* the beneficial effect of the group is greatest in the first part of the task and least toward the end of the task.

5. There is a tendency for the *slow individuals to be more favorably affected* in speed by the group co-activity than the more rapid workers. There are, however, certain striking exceptions.

6. *The variability in output* among the individuals varies generally with the social influence. Hence it is usually greatest in the group work. A striking exception to this occurs in the tests where rivalry is correlated with the social increment, and where only every third or fourth word is written. Here the variability is greatest in the solitary work. This result is in agreement with that of earlier investigators working on different processes.

7. There is suggestive but *not conclusive* evidence that the output of associations in a group where all the members are forming associations in the same category is greater than that in groups in which the members are divided in the trend of their associations between opposite or contrasted categories.

II. *Qualitative Aspects*

8. A greater number of *personal associations* are *produced alone* than in the group.

9. In harmony with this fact is the tendency for subjects to produce *ideas suggested by their immediate surroundings* with *greater frequency in the group* than alone.

10. Less clear cut, but very probable, are the tendencies to produce a *greater number of "free rising" ideas in the group*, and to produce a greater number of words *suggested mainly by the initial stimulus word when working alone.*

III. *Factors in the Social Influence*

11. There are two opposing groups of factors in the influence of the social condition upon the association process. They are:

(1) Facilitating Factors:

(*a*) *Facilitation of movement* by perceptions or ideas of movements in others near us.

(*b*) *Rivalry* intrinsic in the bare social setting of a group working together. Rivalry is well correlated with the beneficial influence of the group in tests of a more mental sort (and less mechanical) such as writing every *fourth* word only. It is not so correlated when each word is written.

The beneficial effects of the group in experiments where the rivalry consciousness is closely correlated with this influence is less than in experiments where it is not so correlated, but where other factors—for example, motor facilitation—serve as the stimulus of the group.

(2) Impeding Factors: distraction, over-rivalry, emotions. Of the two groups, the facilitating is by far the more important in the total effect upon the work.

12. Beside the comparisons already indicated, we may note the general agreement of our work with that of earlier students in the *speed* improvement of mental operations, as shown by the quantity of the product, under conditions of working with others.

B. The Influence of the Group upon the Thought Process

13. In the highly controlled association of the thought process, as typified in written argument, more ideas are pro-

duced in the group than when working alone. Again we find an increased flow of thought owing to the social stimulus.

14. Among the ideas so produced, those of superior quality, however, are of relatively greater frequency in the solitary than in the group work. Ideas of a lower logical value are relatively more numerous in the group work.

15. More words are used in the arguments produced in the group than in those produced in solitude.

16. From the above facts, and also from the introspection of the subjects, we may conclude that the presence of the group influences the reasoner toward a more conversational and expansive form of expression. The more intense logical thinking of solitude gives way in the group to extensity of treatment.

17. These results appear to be related to the common observation that work requiring imagination or more concentrated and original thought is best performed in seclusion. There is also a connection suggested with the writer's experiments upon the social influence in attention and mental work.[1] In that investigation, as well as in the present, the social influence was found to improve the quantity but not the quality of the mental performance.

[1] To be published in the near future.

ATTRIBUTIVE *VS.* COGNITIVE CLEARNESS

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TABLE OF CONTENTS

I. Introduction 184
II. Methods of Procedure 184
Apparatus 184
Observers 186
Instructions 187
III. Results 187
A. Classification of Cognitive Phases 188
B. Complexity of the Problem 196
C. Classification of Attributive Clearness 199
(1) No Clearness reported 199
(2) One level 200
(3) Two levels 202
(4) Three levels 203
D. Conditions of Attributive Clearness 205
(1) Position 205
(2) Fixation 206
(3) Order of Report 208
(4) Quality 210
(5) Length of Exposure 212
(6) Complexity of Material 213
E. Conditions of Cognition 213
(1) Clearness 215
(2) Position 215
(3) Fixation 216
(4) Quality 218
(5) Length of Exposure 219
(6) Color Sensitivity 219
(7) Complexity of Material 220
(8) Duration of Memory Images 221
(9) Practice 221
(10) Direction of Effort 222
(11) Order of Report 223
(12) Association 223
F. Corollaries 225
(1) Levels of Attention 225
(2) Minor Differences of Sensory Clearness 227
(3) Range of Attention 228
IV. Summary of Results 229

I. Introduction

In Professor Titchener's article on the 'Psychological Concept of Clearness,[1] in which he meets the polemical part of Britz's dissertation entitled, 'Eine theoretische und experimentelle Untersuchung über den psychologischen Begriff der Klarheit,'[2] he calls attention at the end of the article to the need of repeating Britz's experiments, for as he says, 'experiment is best met by experiment.'[3]

The present paper reports the results of a series of experiments carried out so far as possible under the conditions laid down by Britz.

II. Apparatus and Method of Procedure

We found it very difficult to reconstruct the experimental procedure from Britz's description. His account is so meager, and he makes so many omissions in his exposition, that we were forced to provide many of the methodical details ourselves. Consequently, instead of referring to Britz's work for the method, we give a complete description of it here.

Apparatus.—Since we did not possess a Schumann tachistoscope, we substituted for it a Wundt gravity tachistoscope. This was rendered almost noiseless by an arrangement of felt pads; indeed the slight thud from the falling shutter very soon became habitual, so that none of the conditions of the experiment was changed by this substitution.

Upon the white exposure cards, 7 x 10 cm. in area, were glued a series of small rectangles cut from colored papers. They were 7 x 12 mm. in area, and were arranged with the longitudinal axis vertical, at a separation of 5 mm., in a horizontal row in the center of the cards. Ten colors were used: two shades of red, an orange, a yellow, a green, a blue, a violet, a purple, a gray, and a black.[4]

[1] *Op. cit.*, *Psych. Review*, XXIV., 1917, 43–61.

[2] Britz, C. A., *op. cit.*, Saarlouis, 1913.

[3] *Op. cit.*, 60.

[4] These are the colors that Britz used (*op. cit.*, 55); but he did not state specifically what qualities he selected. We used the following: R 1, the 'Farbenkreis Rot,' *i.e.*, the 'Hering Red,' Stoelting color No. 1; R 2, the Milton-Bradley 'Red, tint No. 2'; O, the Milton-Bradley 'Orange'; Y, the 'Farbenkreis Gelb,' *i.e.*, the 'Hering Yellow,'

Forty exposure cards were prepared. On half, Series I., there were 5 rectangles; and on half, Series II., there were 6. The sequence of the colors was different on every card, but it was so arranged that every color appeared as often as every other, and equally often in the first, second, third, fourth, fifth, and sixth (for cards of Series II.) places. A particular color never appeared more than once upon the same card. The specific arrangement of the various colors upon the exposure cards appears below in Table I:

TABLE I

THE SPECIFIC ARRANGEMENT OF THE COLORS ON THE EXPOSURE CARDS

Series I						Series II						
Card Number	Order[1]					Card Number	Order[1]					
	1	2	3	4	5		1	2	3	4	5	6
1	5	10	4	2	7	1	1	4	9	3	2	7
2	4	1	5	8	3	2	10	7	5	2	8	6
3	7	9	6	10	2	3	3	8	1	6	10	4
4	8	4	5	3	1	4	5	9	2	7	3	10
5	10	7	2	9	6	5	9	5	4	1	6	8
6	1	2	7	5	3	6	4	1	7	10	5	2
7	2	6	7	9	5	7	6	10	8	9	1	3
8	1	8	3	4	10	8	2	6	10	5	7	1
9	8	10	9	6	4	9	7	2	3	8	4	9
10	2	9	4	7	5	10	8	3	6	4	9	5
11	3	8	10	1	6	11	1	2	5	10	7	8
12	3	5	10	1	8	12	3	9	4	6	1	10
13	4	2	8	5	9	13	8	3	2	1	5	6
14	10	3	2	6	7	14	4	7	9	2	6	3
15	6	1	9	3	4	15	5	4	7	8	10	9
16	9	3	6	4	1	16	9	5	6	3	2	7
17	5	4	8	2	10	17	10	6	8	4	3	1
18	7	6	3	8	2	18	2	10	1	9	8	4
19	9	5	1	7	8	19	7	1	3	5	9	2
20	6	7	1	10	9	20	6	8	10	7	4	5

Stoelting color No. 5; G, the Milton-Bradley 'Green'; B, the 'Farbenkreis Blau,' *i.e.*, the 'Hering Blue,' Stoelting No. 13; V, the Milton-Bradley 'Blue-Violet'; P, the 'Farbenkreis Blau-rot (Purpur),' *i.e.*, the 'Hering Purple,' Stoelting No. 15; Gy, No. 12 in the Hering Gray series; and Bk, Stoelting No. 18, not of the Hering Gray series.

The 'Farbenkreise' which we have in the Cornell Laboratory came to us from the manufacturer with an inversion of two qualities, the Bluish Green and the Greenish Blue samples were interchanged. We mention this fact, since similar errors may have been made in other 'Kreise.'

[1] From left to right.

1, red 1; 2, red 2; 3, orange; 4, yellow; 5, green; 6, blue; 7, violet; 8, purple; 9, gray; 10, black. For the tint and chroma see footnote above.

Six exposure times were used which varied, by intervals of 40 σ, from 40 σ, the shortest exposure, to 240 σ, the longest exposure. The exact times as measured by the Hipp chronoscope and its control apparatus were:[1]

a	*b*	*c*	*d*	*e*	*f*
40.4 ±.9	80.1 ±1.1	119.5 ±2.7	160.6 ±2.6	199.5 ±3.7	239.8 ±5.2

Every card was exposed once at every exposure time. The order was determined haphazardly.

The apparatus was set up in a dark room, and the exposures were made in artificial daylight illumination.[2] The source of light was two 100-watt nitrogen-filled Mazda lamps. These with the 8-inch roundels of 'Daylite glass' were placed in front, to right and left of the tachistoscope, so that no shadows fell upon the exposure cards.

The observations were made through a telescope of 4 diameters magnification. The telescope projected through a large black screen which separated the observers from the apparatus. The eye-piece was 1.50 m. from the exposure card.

Observers.—The observers were Professor H. P. Weld (W); Professor W. S. Foster (F); and the author (D).[3] They were all highly practiced in the introspection of attributive clearness. W and F worked without specific knowledge of the problem other than that given in the instructions. D did not look over the data of W and F until after the completion of the experiment. This had the advantage that his own results were not influenced by the work of the other

[1] Britz does not state precisely what exposure times he used. He merely says that the longest was around 250 σ, and the shortest about 40 σ. He does not say how many steps there were between these extremes, nor whether he employed them all an equal number of times.

[2] Britz made his exposures by daylight, and says that "the greatest care was taken to insure constant illumination" (*op. cit.*, 55). We have found that daylight varies so greatly from hour to hour and from day to day that where constancy is desired artificial light must be employed. For the effect of artificial daylight see A. J. Brown, *Am. J. of Psychol.*, XXVII., 1916, 427–429.

[3] Our thanks are due to Dr. G. J. Rich and to Dr. L. B. Hoisington for acting as experimenter while D observed.

observers; but also the disadvantage that the development of the experiment could not be followed.

The observers served three times a week. The experiment began in February, 1917, and continued until June. By this date all the observers had completed 240 experiments, that is, every stimulus card had been exposed once at every exposure time.

Instructions.—The observers were given the following instructions, which they were required to read at the beginning of every experimental hour:

"At the signal 'ready' place your better eye to the telescope and turn to the fixation point. At the exposure, which will follow the signal 'now,' give your attention to the entire card.

"Immediately after the exposure you are:

(*a*) to name and describe what you have seen; and

(*b*) to give as exhaustive a description as possible of the processes involved during the course of the experiment, particular emphasis being placed upon the report of attributive clearness." [1]

The observer wrote his report while E arranged the apparatus for the next exposure. The observer's desk was illuminated by a third 'daylite' lamp, so that the observations, as in Britz's experiment, were performed in daylight adaptation.

III. Results

The data readily lend themselves to quantitative treatment;[2] and therefore in what follows the quantitative and qualitative aspects shall be carried side by side. Every observer, as we have noted above, was given 240 experiments; in half there were five colored rectangles on the exposure cards, and in half there were six. Altogether, then, 1320 colored rectangles were exposed, every one of which should

[1] We desired to reproduce Britz's instructions, but he does not quote them; consequently we cannot be certain that we have done so. We have, however, incorporated in our instructions all the positive statements that he gives us (*op. cit.*, 55, 62).

[2] Britz did not treat his data quantitatively. He says (*op. cit.*, 55): 'Die Art unserer Problemstellung brachte es mit sich, dass wir auf quantitative Resultate verzichten konnten.'

be accounted for in the observer's reports, either as omitted or as described.

A. Classification of Cognitive Phases

Our first task, following Britz, was to classify the observers' reports upon the basis of the descriptions. This classification, together with the number of cases occurring at every step, appears for the three observers in the 8th, 13th and 18th columns of Table II. These data corroborate Britz's findings. We have been able to identify and to verify the ten phases that he reports. We have further been able to extend the classification to 17 steps.

Below the first step we place the omissions and the subjective reports. The omissions, as Britz observed, were rare.[1] That they were rare is shown by the fact that W omitted only 1.9 per cent.; F, only 0.3 per cent.; and D, 1.2 per cent. The omissions were of two kinds: first of areas that were not noticed, as when, for example, a six-figure card is cognized as five; These cases are shown in the table opposite 'Omitted without knowledge'; and secondly, of areas that were noticed, as when, for example, an interval or an unfilled space was reported at the point that the omitted figure objectively occupied. In illustration we quote from a report of observer D: "there is a space between the two blues, but I did not perceive anything in it, merely cognized the interval" (99). These cases are shown opposite 'Omitted with knowledge.' Britz did not note omissions of this second kind.

We found that the subjective reports, *i.e.*, reports in which more colors are described than objectively appear on the cards, were likewise of two kinds: first, those in which the form of the impression was more or less obscure, being either not mentioned at all, or else reported merely as a spot, flash, speck, blur, etc.; and secondly, those in which the form was definitely cognized as being rectangular. As an example of the first we quote from a report of W on a card from Series I. (a five-figure card) in which, referring to a sixth quality, he says: "I also saw a color, which I called Pink, to the right of

[1] *Op. cit.*, 56: 'Diese Fälle sind zwar selten, kommen aber immerhin vor.'

Green; this pink is a blur of color but is of very good chroma" (26). As an example of the second kind we quote a report of F, following an experiment with a card from Series II. (a six-figure card): "There were definitely seven rectangles" (27).

Though Britz observed that subjective reports were made, he did not distinguish these two kinds.[1] He noted, however, that they occurred more frequently than the omissions. Our results confirm this, and show that W gave 7.8 per cent. subjective reports; F, 6.7 per cent.; and D, 2.0 per cent. At times, all of the observers reported 6 colors when only 5 were exposed; and 7, 8, and even 9 colors when only 6 were exposed.

Britz quite properly excludes such cases,—subjective reports and omissions—from his classification.[2] They were not part of the observer's perception, and therefore do not properly belong to a perceptual classification.

Britz regards as his lowest step the cases in which the observers describe their impressions as spots without being able to say anything definitely about them.[3] We were able to verify this step, as the following reports reveal: "Last two areas to the right vague, certain of them, but they are without color or contour, are not sharp or distinct from the background" (D 48); "Experienced two other fields, but can not name them. They had no distinct form" (W 46). Though these cases do not contain any knowledge of quality or of form, they do of number; "two" in each case were experienced. One of our observers, W, gave cases in which not even this bit of positive knowledge was vouchsafed, and therefore marks a step that is lower in the scale than the lowest reported by Britz. As examples of this step we give the following: "Others experienced, came as flashes, that is all I know about them" (48); "Others, cannot describe them however" (52). It will be observed that neither F nor D reported experiences of this kind; that F did not,

[1] *Op. cit.*, 56.

[2] *Op. cit.*, 56: "Unser besonderes Interesse setzt da ein, wo zum wenigsten irgend etwas, wenn es auch noch so geringfügig zu sein scheint, an dem Farbfelde beobachtet wird."

[3] *Ibid.*, 56.

may be due to the few cases which he reports with indefinite form (see Tables II and III); that D did not, may be due to the fact that he was familiar with the exposure cards.

Our next step, the third, accords with the second step of Britz, in that a tint, *i.e.*, lightness or darkness, is ascribed to the impressions. Examples of this are: F (175) "At the end of the series two dark impressions appeared"; D (20) "Have only a general impression of the three other areas. One on the left dark." The conclusion of this report illustrates our next, the fourth step, for D continues; "other two were colored, but I have no knowledge of the quality." This corresponds with Britz's third step, and may further be illustrated by a report from W: "The blur next the blue was extended, but without distinct outline,—it was perceived as colored" (43). Again; "there were two other colors that almost got 'noted,' but the exposure time was too short" (38).

The next step, comparable with Britz's fourth, includes all the cases in which the general quality of the impressions is reported. "The impressions from the extreme left are reddish, that is all that I can say about them" (F, 144). "I feel sure that there was an orange or some hue much like it in the field. I wish I could describe the 'feel' I had as the shutter fell, the 'feel', 'knowledge' that I saw something clearly, but could not tell just what it was,—that if I had had another instant of time, the color would have been named; but I can say no more about it" (W, 38).

Our next step, the 6th, corresponds with Britz's sixth. We classified at this level those reports in which a specific color is ascribed to an indefinite form. For example: "The first color on left was yellow, the outlines were indistinct—my impression now is that I 'marked' or 'noticed' the yellow as the shutter closed" (W, 8). "The last two to the right came to me merely as color, as yellow and purple" (F, 223).

We obtained a number of cases analogous to those grouped in Britz's fifth step, in which the specific quality reported is only one of the components of the stimulus, as the following examples taken from Britz and from our reports show: "Erkannt wurde eine Rotnüance. Im Nachbild aber ein

reines Orange, daher wird ein Orange angenommen. Jedoch nur in Rotnüance sicher, nicht in seiner Gelbnüance" (p. 58); (W, 58) "Violet was first noted as blue, it wasn't until after the shutter fell that judgment was changed to violet. This has occurred before. As a rule, O, P, and V, are noted in their specific quality, but there have been times when the first judgment of O and P was R, and of V was B." (W, 96) "First apperceived as red; when it was named just after exposure was called red; but visual image and memory of it was that it was purple. Certain that purple was the color."

Britz includes in this step all those cases in which "bei 'zusammengesetzten' Farben nur die eine Komponente zum Bewusstsein kommt, z.B., beim Orange nur die Rotqualität" (p. 61). We did not construct a separate step for reports of this kind, because we thought that this marks a shift in the criteria of classification. Until now the observers' reports were accepted at their face value, and no effort was made to go behind them to the objective stimulus, or to processes which admittedly occurred after the exposure period. Here, however, this has been done, and reports have been classified upon a new basis. If this 'modus operandi' is admitted here, then the classes already discussed should be further divided accordingly as the reports are correct or incorrect; and if incorrect, accordingly as they are partially or totally wrong. A justifiable procedure in an 'Aussage' problem, but not in the present study, in which we are only concerned with the subjective experiences which have been aroused during the exposure of the color fields!

Our seventh step, the last with indefinite form, corresponds with Britz's eighth. The contour is still indefinite, but the quality is fully described, as the following introspections show: "Green, good saturation, medium tint; doesn't refer to any particular place; extended over the right end" (F 111); "Blue and yellow, blurry, more like flashes of color; yellow very light tint, poor chroma" (W 45); "Perception of colored spots. Predominant tone seemed to be blue. One speck to right was yellow, bright and rich, contrasted with the blue which was dark and poor saturation" (D 99).

We now turn to the reports in which the rectangular form is definitely experienced. As Table I. shows, the majority of the impressions were of this kind. Comparatively few belong to the steps that we have thus far described. This is brought out more clearly in Table III., in which the reports are divided according to the form experienced by the observer. The table shows that W perceived the rectangular form in 86 per cent. of his reports; D in 94 per cent. of his reports; and F perceived it in 98 per cent.

The eighth, ninth, tenth, eleventh, twelfth, and thirteenth steps are, with the exception that the perceptual forms were reported as rectangular, the counterparts of the first six steps described above, as the following examples from the observers' reports will show:

The eighth step: W (31), after describing two colored rectangles says: "There were others, I am sure of that, but I can not describe them." F (38) after describing four colored rectangles, continues: "Can't say whether there were 6, 7, 8, or even 9 in the series, but know that there were others." Observer D, as Table I. shows, did not give reports of this nature; he was always definite as to the number of impressions perceived.

The ninth step: W (20), after giving the description of 4 rectangular areas, says: "There were two others, but I cannot describe them." F (97) "7 rectangles, but the quality of only 4 perceived." D (127), reporting 8 rectangular areas, described the quality of four and then concluded: "Haven't the least idea of the qualities of the other areas."

The tenth step: W (10) "There were two other rectangular dark grays, I cannot say whether they had any color"; and again (227), "There was one area to the left of Green that I almost apprehended. I was left with the feeling that if I had had another instant I could have made it out. It was dark, I think." F (222) "Think that in the rest of the series light and dark alternated. I had a sort of 'checker-board' feeling for them." D (51) "Fifth rectangular area was light, but beyond that I can not say."

The eleventh step: W (164) "The remaining areas were

cognized as colored, but I cannot name them." F (125) "Seven colored rectangles; can describe only the first four." D (71) "The first area was colored; perceived that, but couldn't cognize the quality."

The 12th step: W (168) "Bluish, cannot describe it beyond that." F (125) "Last rectangle colored, may have been yellow, a very light gray, nearly white, or some other very pale color." D (157) "Clear perception of five rectangular colored areas. . . . The fourth was cognized as reddish, may have been a red, orange red, or a purple. Only know the general hue."

The thirteenth step: W (215) "Red, cannot be sure of its tint or chroma." F (95) "Purple is the color of the fourth rectangle from the left. Just a name, I can't describe it." D (11) "First rectangle from the left, blue, just hue."

The following reports characterize the 14th step: W (237) "Rectangle, violet, dark, cannot say about chroma"; F (74) "Two blue rectangular figures, they were different, don't know just exactly how, think that one was dark and one light"; F (108) "Two reds, one very dark, other slightly orange-red, and lighter." We may identify this step with Britz's seventh phase.

Our next step, to which the fourteenth is very closely related, is described in the following reports: D (1) "Perception of six colored fields upon white background. The three to the left were definitely bounded and rectangular, while those to the right were patches of color without definite outlines. Of the rectangular areas, the first was colored; the second, was yellow, bright; and the third was blue, well saturated." The fourteenth step includes the reports in which hue and brightness are perceived, the fifteenth those in which hue and chroma are perceived. Other examples of this type are: F (147) "Do not think that blue-green was very well saturated"; F (216) "Purple and orange were not of good saturation"; W (124) "Blue, pretty good chroma, I cannot say as regards tint."

The sixteenth step is comparable with Britz's ninth. The descriptions are complete; form, hue, tint, and chroma are

definitely reported, but not the 'paper' character. In illustration the following reports are quoted: W (97) "Last rectangle to the right red, a dark red, good chroma"; F (71) "Perception of 5 colored rectangular areas . . . third blue, medium tint, and rather poor saturation; 4th green, slightly yellowish of fairly light hue, and fair saturation"; D (57) "A number of rectangular areas. . . . The extreme left one was jet black, the extreme right one was a rich, dark, deep blue."

Our last, and the seventeenth step, is illustrated by the following: W (22) "In the black I saw the texture of the paper"; (117) "Black, shiny, enamel-like"; F (79) "Black, was not velvet black, but a sort of dirty, or handled, or rubbed black"; (234) "First rectangle light orange, poor saturation, looked like a cold water paint on a wall, a bit like those in the laboratory"; D (56) "The fourth rectangle gray, medium tint, certain about it, could even see the grain of the paper"; (70) "Rectangle to the extreme right blue, light, but of good chroma, paper quality, hard and shiny"; (87) "The first rectangle was purple, dark, well saturated, but papery, dull, flat"; (108) "The central rectangle was gray, which was quite definite, it was a little darker than middle gray, more clearly cognized than at any other time in the series, even perceived the grain of the paper." This step finds no counterpart in Britz.

Neither can we, for that matter, give a step which is the exact complement of Britz's tenth phase; not because we lack reports of the kind that he quoted,—for our observers did occasionally give similar accounts,—but because such action would mark a shift in our criteria of classification, a point which we have already sufficiently discussed.

A résumé of the various phases described above is offered in Table II., which gives, besides, the number of cases occurring at every step. Table III., which follows it, shows the number of times the colored rectangles were perceived with and without definite form.

Both tables show that the reports may be divided into classes which differ according to the perception of the form.

TABLE II

SHOWING THE VARIOUS COGNITIVE PHASES, THE NUMBER OF CASES OCCURRING AT EVERY PHASE, AND A DIVISION OF THESE CASES ACCORDING TO THE ATTRIBUTIVE CLEARNESS OF THE PERCEPTIONS

Degrees of Cognition	Step	Observer																	
		W								F					D				
		Clearness								Clearness					Clearness				
		Not Reported	One Level	Two Levels		Three Levels			Total	Not Reported	One Level	Two Levels		Total	Not Reported	One Level	Two Levels		Total
			Upper	Upper	Lower	Upper	Middle	Lower			Upper	Upper	Lower			Upper	Upper	Lower	
Omitted																			
Without knowledge		3	6	0	6	0	0	1	16	1	0	0	1	2	5	1	0	5	11
With knowledge		4	3	0	5	0	0	0	12	0	1	0	1	2	3	1	0	2	6
Indefinite form																			
Added		1	5	0	9	0	0	1	16	1	0	0	2	3	3	1	0	4	8
Others experienced	1	1	2	0	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0
A definite number experienced	2	18	16	0	35	0	0	6	75	0	2	0	0	2	9	3	0	25	37
Tint	3	1	3	0	6	0	0	0	10	0	4	0	0	4	0	3	0	3	6
Colored	4	6	5	0	11	0	0	4	26	1	2	0	0	3	0	4	0	11	15
General quality	5	4	1	0	6	0	0	0	11	1	2	0	0	3	1	0	0	4	5
Specific quality	6	5	2	2	10	0	0	1	20	0	6	0	0	6	0	0	0	0	0
Hue, tint, chroma	7	11	11	0	14	0	2	0	38	1	2	0	0	3	5	2	0	1	8
Definite form																			
Added		33	23	0	39	0	0	0	95	16	63	0	11	90	3	4	0	13	20
Others experienced	8	7	7	0	8	0	0	0	22	2	4	0	9	15	0	0	0	0	0
A definite number experiences	9	109	60	0	93	0	0	0	262	24	91	0	29	144	19	111	1	71	202
Tint	10	4	2	0	6	0	0	0	12	2	25	0	0	27	13	56	5	29	103
Colored	11	54	20	3	74	0	0	3	154	5	53	2	10	70	7	67	4	28	106
General quality	12	12	13	7	5	0	0	0	37	31	147	15	10	203	13	82	48	12	155
Specific quality	13	27	21	17	5	2	2	0	74	62	245	41	1	349	29	135	69	9	242
Hue and tint	14	16	12	15	3	0	0	0	46	14	56	8	0	78	4	50	29	0	83
Hue and chroma	15	2	1	0	0	0	0	0	3	2	26	0	0	28	1	9	0	0	10
Hue, tint and chroma	16	164	113	179	7	2	3	0	468	27	238	30	0	295	25	180	88	0	293
Paper character	17	0	0	1	0	1	0	0	2	5	49	7	0	61	1	29	8	0	38
Total		482	326	224	344	5	7	16	1,404	195	1,016	103	74	1,388	141	738	252	217	1,345

TABLE III

SHOWING THE TOTAL NUMBER OF TIMES THE COLORED RECTANGLES WERE PERCEIVED WITH AND WITHOUT A DEFINITE FORM, AND A DIVISION ACCORDING TO THE ATTRIBUTIVE CLEARNESS OF THE PERCEPTIONS

O.	Perception of Form	Attributive Clearness							Total
		No Report	One Level	Two Levels		Three Levels			
				Upper	Lower	Upper	Middle	Lower	
W....	Indefinite	47	45	2	93	0	2	12	201
	Definite	428	272	222	240	5	5	3	1,175
F.....	Indefinite	4	18	0	2	0	0	0	24
	Definite	190	997	103	70	0	0	0	1,360
D....	Indefinite	18	13	0	48	0	0	0	79
	Definite	115	723	252	162	0	0	0	1,252

Table II. shows that within each of these classes the steps are comparable; and that it is only in the very highest qualitative phases that 'form' seems indubitably bound up with the perception.

This classification marks, step by step, the development of the perception from the simple to the complex. It is logically derived from the reports and the descriptions of the observers. But what has this logical classification to do with attributive clearness? We turn for an answer to the introspections, to that second part of the instructions which requires the observers to 'give as exhaustive a description as possible of the processes involved during the course of the experiment, particular emphasis being placed upon the report of attributive clearness.'

B. COMPLEXITY OF THE PROBLEM

Before turning to this evidence it may be well to mention, as a sort of qualifying introduction, that neither the method nor the instruction was conducive to good psychological description. The observers were required to note meaning and process, and to give a full report of both. An extremely difficult instruction! for the observers tended either to concentrate upon the fulfillment of the first part, in which case the description of process was vague and uncertain; or to concentrate on the introspection of process, in which case the statements of meaning (in the last analysis that is what

naming and describing the colored rectangles implies) were neglected and incomplete. We need not be surprised, therefore, that under these unfavorable conditions cognitive clearness should have been confused with (and reported for) attributive clearness.[1] The first part of the instructions 'set' the observers for meaning; it is only natural that this attitude should have been carried over to the second part, and the meaningful kind of clearness, the cognitive, have been mistakenly reported for the attributive. That this is the natural and, indeed, unavoidable consequence of the instructions is shown by the fact that all of Britz's observers, according to his own showing, reported solely the cognitive type of clearness; and further by the fact that our own observers, who had had extensive practice in the introspection of attributive clearness, and who had never experienced any difficulty in reporting it in other experiments in which clearness-reports were called for, found their task very arduous under the conditions of this experiment.

That Britz's observers were reporting cognitive clearness only is shown by the sample introspections that he gives (p. 60); and also by the fact that the expression 'clear' was used only in the higher perceptual phases. Britz himself points out: "Ueber den 'Klarheitsgrad,' der hier anzunehmen wäre, wurde meistens nichts geäussert. Auf den höheren Stufen aber, zu denen wir nun gelangt sind, ist die Aussage insofern modifiziert, als die Beobachter selbst zu Protokoll geben, das eine Farbe klar oder gar sehr klar war" (p. 59). Additional evidence is afforded by the following: "Sie ordnen für den jeweiligen Versuch sehr oft aus eigener Initiative die Farben nach ihrer Klarheit" (p. 59); and "Wir sehen, dass die Vpp. sich zwar sehr oft damit begnügen, die eine Farbe als klarer einer anderen gegenüberzustellen, aber andererseits doch auch manchmal anzugeben wissen, warum sie der betreffenden Farbe grössere Klarheit zuschreiben" (p. 60). That the observers could arrange the colors in order of clearness, and could explain why one color was clearer than

[1] For a differentiation of these two kinds of clearness see E. B. Titchener, 'Feeling and Attention,' 1908, 238 f; and S. S. Colvin, 'The Learning Process,' 1911, 255 f.

another, is proof positive that Britz was dealing with the cognitive type.

That our observers found it difficult to report both meaning and process is best shown in their own words. W says in one of the early reports: "The report is so complicated that it seems foolish to talk about attributive clearness"; and again, "Under the conditions of this experiment I have no criteria for distinguishing attributive clearness from cognitive." W was also throughout the experiment more or less disturbed by after-images. "The colors persisted in the after-period, and at present I have the notion that the relative clearness in the after-period influences my report of the processes during the time of the exposure. That is to say, it is very difficult to draw a line, with everything else that I have to do, between these two periods." Again, in a later experiment, "I am 'set' this morning for the problem of clearness during the exposure-period, and I find it difficult to remember the colors distinctly enough to describe them." F is even more explicit. He says, in one of the early experiments, "The instructions ask too much for an adequate report, and any side of the report (naming, describing, number, order, form, etc.) could, it seems to me, be 'set for' without making the least difference in the processes which go on in the actual exposure period"; and again, in a later experiment, "You know a lot about the colors after the exposure is over, but I am perfectly sure you lose a lot; as you start writing other aspects become non-reportable. It isn't so much the way you set yourself before the exposure that determines the report, but how you go to work after the exposure. I feel pretty sure that if E should call out after the exposure 'Report on chroma' I could report all chromas adequately, whereas usually by naming colors, mentioning clearness, brightness, etc., I lose certainty about chroma." D expressed a similar idea: "What I report doesn't depend so much upon what I experience as upon where I start the report. When I concentrate upon the naming and description of the colors, my report on process is uncertain, and *vice versa*."

C. Classification of Attributive Clearness

The reports were not only classified upon the perceptual basis given above, but they were also classified upon the basis of sensory clearness. In some of the experiments, because of the inherent difficulties mentioned above, the observers were not always willing or able to record clearness; these cases appear in the tables under the caption "Clearness not reported." In other experiments, the processes aroused by the stimulus were all experienced at one (the upper) level; in still others they were divided into two levels, the clear and the obscure; and in others again the processes were reported as having been experienced at three levels of clearness. These cases appear in the Tables under the respective captions "Clearness, One Level," "Clearness, Two Levels," and "Clearness, Three Levels."

1. *Clearness Not Reported.*—In rather a large proportion of the experiments—large, considering that the observers were especially directed to report upon clearness—clearness was not recorded. This was true in over ⅓ of the experiments for W, in nearly 1/8 for F, and in almost 1/10 for D. These occasions for F were evenly distributed between the two series of exposure cards, Series I. and Series II.; so that for him reportability of clearness was not so much a matter of simplicity of material as it was a matter of direction of effort: *e.g.*, (48) "I still am not always able to report upon clearness. The fact that I have to name, and that naming is not an absolute immediate process, but one which interferes with the memory after-image, prevents me from making a good report on the processes of the exposure-period itself." While this is also true of W and D, they are influenced to a greater extent by the complexity of material; for both show a greater number of failures in Series II.

All of the perceptual steps are represented in these reports; but relatively fewer low steps, relatively fewer perceptions of indefinite form (as is shown by Table III.), are reported under these conditions than under the conditions in which clearness is reported. Thus do the results bear out the

observers' introspections given above: when full effort is given to recognizing and naming the colors the task is more adequately performed than when attention is divided between this and a description of process.

TABLE IV

SHOWING THE NUMBER OF EXPERIMENTS IN WHICH ATTRIBUTIVE CLEARNESS WAS NOT REPORTED; AND THE NUMBER IN WHICH ONE, TWO AND THREE LEVELS WERE REPORTED

Observers	Series	Attributive Clearness			
		Not Reported	One Level	Two Levels	Three Levels
W	I.	33	35	49	3
	II.	48	21	49	2
	Total	81	56	98	5
F	I.	17	92	11	0
	II.	16	86	18	0
	Total	33	178	29	0
D	I.	3	90	27	0
	II.	20	48	52	0
	Total	23	138	79	0

2. *Clearness One Level.*—In the reports of all the observers every one of the 17 perceptual steps is represented when the processes aroused by the stimulus-card are judged to be of equal clearness, as Table II. and the following introspections show: W (32) "Five areas. Naming from right to left they were black rectangle, good deep black, a rich black; next a blue rectangle, good chroma, medium tint; next, yellow rectangle, I cannot describe it; then there were two others. The field as a whole was clear." Here we have one level of clearness, and at least three levels of cognition. Again from W, "Gray, a little darker than middle gray; pink, might have been a purple of light tint; red, cannot describe further; blue, good chroma, dark tint; three other colored areas. Duration of gray and pink rectangles was longer than that of other areas. Red and blue were momentary flashes. If I have not said it before I now wish to say for all time that the colors are undoubtedly noted, cognized, apprehended, as

objects, as 'Reds' and 'Blues,' etc. The name of the hue is the name of the object. There is no awareness of attributes during exposure; of that I am now sure. After exposure I can hold the 'object' in imagery or 'memory,' and by taking successively the hue, tint and chroma attitudes I can describe it. My reports of clearness are also post-exposure descriptions. The experience is recalled as vivid or obscure. I avoid inferring that, because the object has several degrees of cognitive clearness, it must therefore have several degrees of attributive clearness. Sometimes this seems to be the case, but many times it has seemed to me that a color cognized at low degree was for a brief duration as clear attributively as if cognized at a high degree. This is true in the present instance; all the impressions at the time of the exposure seemed equally clear" (150). Here we have one level of attributive clearness, and beside one addition at least five levels of cognition. F (60): "5 colored rectangles, purple, black, gray, blue, yellow; all on upper level, all equally clear during exposure. Grey the only one particularized, it was a medium light grey, seemed to me to have a slight lustre. If I had not tried to get all the colors by name I think I could have particularized the others." Here we have one level of clearness, and certainly two degrees of cognition. Again (71), "Gray, green, red, 'something,' blue. I named as fast as I could but could only name four. Green and blue came up easiest and were the ones particularized. Green rectangular, slightly yellow rather than blue, of fairly light hue and fair saturation. Blue, rectangular, was not dark, rich blue, but a medium tint and rather poor saturation. Grey and red rectangular, grey light, red just a name. 'Something' was a color, that is all that I can say. All processes during time of exposure at upper level." The processes were at one level of clearness, and yet the colored rectangles were cognized at four. D (8) "5 rectangles, knew the qualities of all immediately after the exposure, but before I had completed the naming—I started from the left—I lost my knowledge of what I had perceived. First was yellow, light tint, good chroma; second, purple, rich deep color;

memory after-image had disappeared before I had named the third, have a feeling that it was blue or bluish, but am certain that it was dark. Can say very little about the last two, except that the last one was the darker of the two. At the time of the exposure all the processes were equally clear, and attention was evenly distributed over the entire field." One level of clearness, and several degrees of cognition!

3. *Clearness Two Levels.*—When two levels of clearness were observed, the lower perceptual steps were never reported from the upper level; and conversely the highest perceptual steps were never reported from the lower level. Indeed, in the upper clearness levels the form was, with two exceptions for W, always perceived; whereas the perceptions with indefinite form were reported proportionally, and for W and D actually, more frequently from the lower level than from any other basis of report.

This result seemingly indicates, at least as far as form is concerned, that attributive clearness is one of the conditioning factors in the perception. We shall return later to a discussion of this point; but we should observe here that the condition, if such it be, is not absolute; for the perceptual steps, reported from the two levels, overlap. Processes of very different degrees of clearness may be similarly cognized. All the observers give instances of this overlapping. For illustration, W at the 11th perceptual step cognized 3 areas from the upper level of clearness and 74 areas from the lower level; at the twelfth step, 7 from the upper and 5 from the lower; at the thirteenth step, 17 from the upper and 5 from the lower; at the fourteenth, 15 from the upper and 3 from the lower; and at the sixteenth step, 179 areas from the upper level of clearness and 7 from the lower. The results of the other observers are corroborative. The following introspections are selected by way of illustration: W (104) "Orange, good chroma, medium to light tint, form definite, to left of center; blue good chroma, light, form definite, next to orange, nearer center; purple, fair chroma, medium tint, form definite, last to right; about three other colors. The three named seemed to stand out from the remaining colors

as attributively more clear. I again think that there were two levels, and that the lower did not change during exposure and neither did the upper. The colors reported were apprehended but not named during exposure; they were described from memory after-image." F (7) "Purple at center; orange next to purple to left; yellow next to purple to right; other colors present. I could match the purple with a series of purples; it impressed itself upon me as a particular purple quality (hue, tint and chroma combined). I do not feel at all able to match the orange or the yellow; they seemed ordinary colors to me. The three colors reported seem to stand at a high level of clearness. Other colors and background all at lower level." D (24) "The three left-hand areas were very clear, the areas to the right were unclear. The qualities of the left-hand areas were red, light-blue, and black. The red was a rich red of medium tint; could pick it out from a series it was so definite. The light blue was also definite, light, but of good chroma. The black was jet. All three of these areas were rectangular and sharply outlined and distinct from the background. Of the two areas on the right I can report that the quality of the outside color was dark. Can report absolutely nothing about the fourth area. Neither of these two areas was distinctly defined from the back-ground."

3. *Clearness Three Levels.*—Besides the two types of clearness already mentioned, W reported a three-level type, *i.e.*, the processes during the exposure were at three levels of clearness: some were maximally clear, some were of medium clearness, and some were obscure. The upper and middle levels were cognized at approximately the same perceptual steps, that is, at the higher; whereas the processes of the third clearness level were cognized at the lower perceptual steps. We shall return later to a discussion of the multi-level type; here we note that W reported this type only 5 times, and those in the early part of the experiment.

Thus in sensory clearness differentiated from cognitive.[1]

[1] Though we prefer the name 'clearness,' we think on the whole for the sake of clarity and unambiguity that Titchener's recent substitution 'vividness' is preferable. The term 'clearness' may then be given over to cognition. *Cf.* E. B. Titchener, 'A Beginner's Psychology,' 1915, 66; *Psych. Review.*, XXIV., 1917, 55.

A comparison of the perceptual classification with the attributive classification (Table II.) reveals four alternatives: an impression may be attributively clear and cognitively clear; attributively clear and cognitively unclear; attributively unclear and cognitively clear; or attributively unclear and cognitively unclear.

So far nothing new has come from our study. We have, besides substantiating Britz's perceptual classification, merely verified what has long been known about the distribution of consciousness during a tachistoscopic exposure.[1] Yet our work shows that, even under the unfavorable conditions of Britz's experiment, attributive clearness can be realized. Indeed, if in the light of our results we return to Britz, we can find instances of attributive clearness; not to be sure in what his observers report as 'clearness,' for they used the term in another sense as the following plainly shows, "Bei unseren Versuchen wird der Ausdruck Klarheit lediglich in dem Sinne gebraucht, dass nach der Ansicht der Versuchperson eine bestimmte Farbennüance in ihrem charakteristischen Tone, ohne noch irgend einen Zweifel zuzulassen, erlebt wurde;"[2] nor in the sense in which Britz himself applied the term; but incidentally, in phenomena reported and neglected. For example, "Wir haben z.B. gesehen, dass eine Farbe, das Blau, nur als Qualität usw. erlebt wurde,—nach unserer Skala also in einem ziemlich niederem Stadium,—und trotzdem sehr hervorstechen kann."[3] This account with its process 'standing forth' is very suggestive of what we mean by sensory clearness, as also frequently is the observer's employment of 'Eindringlichkeit.' But Britz was

[1] E. B. Titchener, 'Feeling and Attention,' 1918, 238. F. Schumann, *Bericht des I. Kong. für exp. Psych.*, 1907, 170.

[2] *Op. cit.*, 69. Britz continues: "Nach meiner Ansicht is dies eine Bezeichnung, die man speziell nur dem spezifisch 'Farbigen' gegenüber zu benutzen pflegt, bei Grau and Schwarz wird sie wohl kaum gebraucht werden." This is in direct contradiction to the evidence on p. 60, where an illustration of his higher phases Britz quotes from 14 introspections. Clearness is mentioned in six: It is used twice in connection with green, and once in connection with red, yellow, gray and black. If these introspections are at all representative, clearness is used with black and gray as with the colors.

[3] *Op. cit.*, 61.

in search of a name instead of a phenomenon, and he consequently overlooked these leads which, had he followed them, might have brought fruitful results.

The aspect of clearness which our observers reported satisfies the requirements of an attribute: it is inseparable and independently variable. That these conditions are fulfilled is shown in the preceding tables. Whenever the experiment permitted of an attributive description our observers reported clearness. The Tables show a number of cases in which the observers failed to report clearness; but their failure does not mean that the criterion of inseparability has been violated; it signifies merely that, under the conditions of the experiment, an attributive description of the processes was occasionally not possible. We see from Table II. that processes of very different qualities have the same clearness; and contrariwise that processes of the same quality have very different clearnesses; and thus is the criterion of independent variability satisfied.

D. Conditions of Attributive Clearness

The dual-level reports, in which the clear and the obscure processes existed side by side in the same consciousness, offer an excellent opportunity for studying the conditions of clearness effective in this experiment.

1. *Position.*—The frequency in which the various parts of the exposure-card appeared at the upper level of clearness is different for all three of the observers. As is shown by Table V., in the greatest per cent. of W's dual-level reports (44 per cent.) the upper level of clearness is at the right end of the exposure card; whereas in 86 per cent. of F's reports it is at the center of the card; and in 55 per cent. of D's reports the upper level is at the left end of the card. W reports almost no cases (4 per cent.) in which the upper level is at the left end; F very few in which it is other than at the center; and D reports only 6 per cent. in which the upper level is at the right end. These data show that certain areas are favorable for clearness. There are, however, such great individual differences between the three observers—they

TABLE V

SHOWING THE NUMBER OF TIMES, IN PERCENTAGES, THAT THE UPPER LEVEL, OF THE DUAL-LEVEL REPORTS, APPEARED AT THE VARIOUS POSITIONS ON THE EXPOSURE CARD

O.	Position of Upper Clearness Level				Total Reports
	Left	Center	Right	Ends	
W....	4	38	44	14	98
F.....	7	86	7	0	29
D....	55	31	6	8	79

could hardly have been greater—that if we accept position as a determinant of clearness, as has recently been suggested by Bollman[1] we must regard it as a condition peculiar to every observer.

2. *Fixation.*—Two observers, F and D, reported fixation in a great proportion of the experiments. D reported it casually, while F used it as a means of reference, and therefore reported it in a greater per cent. of the cases. The number of times that the fixation was reported and the per cent. of times that it was reported at the left, at the center, and at the right, appears for the three kinds of reports—those in which clearness was not given, those in which it was given at one level, and those in which it was given at two levels—in Table VI. The differences in the fixation in the three kinds of report is too small to be of significance.

TABLE VI

SHOWING THE POSITION OF THE FIXATION POINT IN THE EXPERIMENTS IN WHICH NO ATTRIBUTIVE CLEARNESS WAS REPORTED, IN THOSE IN WHICH THE ATTRIBUTIVE CLEARNESS OF THE PROCESESS AROUSED BY THE STIMULUS CARD WAS AT ONE LEVEL, AND IN THOSE IN WHICH IT WAS AT TWO LEVELS

O.	Fixation	Attributive Clearness					
		Not Reported	Number Cases	One Level	Number Cases	Dual Level	Number Cases
F.....	Left.....	100%	19	1.5%	134	4%	25
	Center..			95.5%		92%	
	Right...			3.0%		4%	
D.....	Left.....	11.2%	18	1.2%	83	2%	42
	Center..	88.8%		98.8%		96%	
	Right...					2%	

"Number Cases" shows the number of cases in which the fixation was reported.

[1] Alma Bollman, *Am. J. of Psych.*, XXXI., 1920, 87–90.

The position of the fixation in the dual-level reports, however, appears to be significant. For, as is shown by Table VII., where a correlation is drawn between the fixation and the position of the upper level of clearness, fixation at the right or at the left insures for both observers, that that area will be clearly experienced. When the fixation is at the center, the correlation is not so great, though it is not much less for F. Still, F, shows exceptions which are more or less the rule with D.[1] In nearly half of the experiments in which the fixation is at the center, the upper level of clearness for D is at the left; in not quite a third of them the position of the upper clearness level corresponds with the point of fixation.

These facts indicate that fixation is one of the conditions

TABLE VII

CORRELATION OF THE POINT OF FIXATION WITH THE POSITION OF THE UPPER CLEARNESS LEVEL

O.	Fixation	Position of Upper Clearness Level				Number Cases
		Left	Center	Right	Ends	
F.....	Left.....	4%				
	Center....	4%	84%	4%		25
	Right.....			4%		
D....	Left.....	2%				
	Center....	41%	31%	12%	12%	42
	Right.....			2%		

"Number of Cases" shows the number of dual-level reports in which the fixation was reported.

of clearness in this experiment. It is cut across in D's case by some other factor or factors, which almost totally obscure it. In F's case, on the contrary, the correlation is so high that fixation appears for him to be the sole condition necessary for clearness. Since D's data show the effect and presence of other conditions, it may also be that there are other conditions operative in F's case, and that their presence is concealed in his general results,—their action being in the same direction as the point of fixation. This, indeed, as we shall presently see, turns out to have been the case.

[1] These cases and the 'One Level' reports show that our observers were following the directions to spread the attention over the entire card and not to concentrate at the point of fixation.

3. *Order of Report.*—All three observers reported that they were consciously disposed toward a certain definite order of naming the colors. W was set to report the colors from right to left: (6) "I set myself to give equal attention to the field and to name the colors from right to left." D in a large per cent. of the cases, following the order in reading, began his reports from the left. The method, however, was the result of conscious adaptation: "Resolved, in order to get more of the colors, to name them in order from left to right." F, in the early experiments, began his reports as D by reproducing (2) "from left to right as in reading," but he very soon adopted what he called the natural method; "I find that there is a natural order of naming the colors; I don't at all name from left to right, but from the middle in both directions, usually first to the left and then to the right."

Table VIII

Showing the Order of Naming the Colors in the Experiments in which no Attributive Clearness Was Reported, in Those Experiments in which the Attributive Clearness of the Processes Aroused by the Stimulus Was at One Level, and in Those in which It Was at Two Levels

O	Report from	Attribntive Clearness					
		Not Reported	Number Cases	One Level	Number Cases	Dual Level	Number Cases
W.....	Left.....	7.5%	80	5.8%	52	13.6%	81
	Center..	27.5%		38.4%		50.6%	
	Right...	60.0%		44.2%		30.8%	
	Ends....	5.0%		11.6%		4.9%	
F.....	Left.....	30.4%	23	8.6%	150	17.7%	28
	Center..	69.5%		89.4%		82.3%	
	Right...			2.0%			
	Ends....						
D.....	Left.....	63.6%	22	81.0%	132	54.5%	68
	Center..	36.3%		13.7%		32.3%	
	Right...			0.8%		6.0%	
	Ends....			4.5%		7.3%	

"Number Cases" shows the number of cases in which the method of reporting was designated.

As is shown in Table VIII. the observers followed the method toward which they were 'set' pretty consistently throughout the experiment. F shows the greatest consis-

tency, W the least. Indeed, W in more than 50 per cent. of the cases of the dual-level reports names the colors first that are at the center.

Table IX. shows the correlation between the method of naming the colors and the position of the upper level of clearness of the dual-level reports. The correlation is very high for all the observers. For example: when W named the colors first at the center, the upper level of clearness in the greatest per cent. of the cases was at the center; when he named first at the left, the upper level of clearness was in the greatest number of cases at the left; when he named the ends first, the ends in most cases were clear and the center obscure. So also for the other two observers.

TABLE IX

CORRELATION BETWEEN METHOD OF REPORTING AND POSITION OF UPPER LEVEL OF CLEARNESS OF THE DUAL-LEVEL REPORTS

O.	Report from	Position of Upper Clearness Level				Number Cases
		Left	Center	Right	Ends	
W....	Left.....	1.2%	2.4%	5.0%	5.0%	81
	Center....	1.2%	34.6%	14.8%		
	Right.....	2.4%	1.2%	21.0%	6.2%	
	Ends.....			1.2%	3.7%	
F.....	Left.....	7.1%	7.1%	3.5%		28
	Center....		78.8%	3.5%		
	Right.....					
	Ends.....					
D....	Left.....	50.0%	1.5%	1.5%	1.5%	68
	Center....	4.4%	26.4%	1.5%		
	Right.....		1.5%	3.0%	1.5%	
	Ends.....			1.5%	5.8%	

"Number Cases" shows the number of cases of the Dual-Lever reports in which the Method of Reporting was designated.

These tables corroborate the observers' introspections and show, we believe, that the tendency or 'set' to name in a particular spatial order is a determinant of clearness. It might be argued that the order of reporting, instead of being a condition of clearness, is itself conditioned by clearness. That may be true under certain conditions. Here, however, we must regard the general tendency to name from certain

fixed points, a tendency that our observers reported in their introspections and that was clearly shown in their results, as a determinant of clearness.

This determinant explains the results of the correlation of fixation and the position of the upper clearness-level. It accounts for the apparent discrepancy of D's and the uniformity of F's results. D, as we have found, was 'set' toward the left; his fixation was at the center. The one condition pulled one way, the other condition another way. Under such a conflict of determinants we should expect to find that now the one and now the other was effective; and unless there were other determinants which cut across these two, that the upper level of clearness would be at the one or the other of these two areas, and that it would most frequently be at the area of the stronger determinant. That represents the facts in D's case: the upper level of clearness is at the center and left in 5/6 of the cases; it is at the left more frequently than at the center; so that, if our logic is correct, the predetermination, the 'set' to name from the left, is for D in this experiment a stronger determinant of clearness than fixation. For F, the two conditions are effective in the same direction; they facilitate each other. F's fixation was at the center, and he was set to name first at the center. His results are consistent throughout; the clearest area in 86 per cent. of the cases was at the center. W unfortunately did not report fixation; his results, however, show the same discrepancies as D's, and are, we think, to be explained in the same manner.

4. *Quality.*—The qualities of the stimuli, irrespective of the quality reported by *O*, were noted and recorded according as they appeared in the upper and the lower levels of clearness. The number of cases and the per cent. for each level of clearness are given in Table X. for every quality.

This table shows that some of the qualities are more frequently experienced in the upper clearness-level than others, *i.e.*, some are clearer in their own right. Therefore, since every color appeared equally often, and an equal number of times at the various positions on the card, we conclude that quality is a determinant of clearness.

TABLE X

REPORTS OF THE DUAL-LEVEL FORMATION, SHOWING THE NUMBER OF TIMES AND THE PER CENT. THAT THE DIFFERENT COLORS FELL IN THE UPPER AND THE LOWER LEVELS

O.	Level of Clearness	Quality									
		R_1	R_2	O	Y	G	B	V	P	Gy	Bk
W....	Upper.....	18	14	26	31	27	40	20	17	17	24
		36%	24%	49%	57%	50%	77%	33%	36%	30%	52%
	Lower.....	32	44	27	23	27	12	41	30	40	22
		64%	76%	51%	43%	50%	23%	67%	64%	70%	48%
F.....	Upper.....	10	5	13	14	10	12	16	11	4	9
		63%	36%	76%	82%	63%	80%	76%	79%	24%	50%
	Lower.....	6	9	4	3	6	3	5	3	13	9
		37%	64%	24%	18%	37%	20%	24%	21%	76%	50%
D....	Upper.....	24	13	20	33	13	42	31	22	17	33
		61%	27%	57%	80%	30%	87.5%	70%	63%	35%	72%
	Lower.....	15	34	15	8	30	6	14	13	31	13
		39%	73%	43%	20%	70%	12.5%	30%	37%	65%	28%

The rank-order of the colors according to the frequency in which they appeared in the upper level of clearness is given in Table XI. There is a fairly close agreement among

TABLE XI

RANK-ORDER OF THE COLORS ACCORDING TO THE FREQUENCY IN WHICH THEY APPEARED IN THE UPPER LEVEL OF CLEARNESS

O.	Rank Order									
	1	2	3	4	5	6	7	8	9	10
W.....	*B*	*Y*	*Bk*	*G*	*O*	R_1	*P*	*V*	*Gy*	R_2
F.....	*Y*	*B*	*P*	*O*	*V*	R_1	*G*	*Bk*	R_2	*Gy*
D.....	*B*	*Y*	*Bk*	*V*	*P*	R_1	*O*	*Gy*	*G*	R_2

the observers as regards the colors that make for clearness and those that make of obscurity. *Y*[1] and *B* are most frequently in the upper level, whereas R_2 (the tint) and *Gy* are most frequently in the lower. For the other colors, which occupy intermediate positions, the individual differences are greater; only one is ranked uniformly by all the observers, the saturated red, R_1, which is in sixth place.[2]

[1] This corroborates Titchener's introspection (*cf.*, *Textbook of Psychology*, 269).

[2] Against the general belief that red is a quality that is inherently clear, both the saturated color and the tint were uniformly ranked low by our observers. The principle upon which this quality is used in danger signals must be of another origin.

This condition explains some of the irregularities which we have noted above. It explains, for example, the cases of W and D in which the ends were at the upper levels of clearness and the centers obscure; and also the cases in which F, though doubly conditioned for clearness at the center, reported the clearer area at the right or at the left.

5. *Length of Exposure.*—The dual-level formation is to a slight extent correlated with length of exposure. Evidence is given in Table XII. which shows that the greatest per cent. of the dual-level reports were obtained during the short exposures. This result holds for all three observers. It becomes more apparent when the exposures are arranged in three groups, as rapid, medium, and slow.

TABLE XII

THE PER CENT. OF THE DUAL-LEVEL REPORTS THAT OCCURRED AT THE VARIOUS EXPOSURE TIMES

O.	Length of Exposure					
	a	*b*	*c*	*d*	*e*	*f*
W....	18.4	20.6	17.3	16.3	14.2	13.2
F.....	20.7	24.1	13.7	17.3	13.9	10.3
D....	22.8	17.7	15.2	15.2	15.2	13.9

Though the length of exposure appears to be a condition of the dual-level reports, it is not a condition of clearness in those reports. The results presented in Table XIII. show no correlation between the position of the upper level of clearness and the exposure-time for W and F. D, however, gives a slight correlation; the center was more frequently reported clear during the short exposures, and the left more frequently during the medium and long exposures. Nevertheless, we do not regard this result as evidence of a determinant of clearness; rather it shows under what conditions the determinants already mentioned are effective for D. In the short exposures, his fixation is the more effective; in the medium and the long, his predisposition for the left is the stronger.

TABLE XIII

CORRELATION OF THE POSITION OF THE UPPER CLEARNESS LEVEL OF THE DUAL-LEVEL REPORTS WITH THE TIME OF EXPOSURE

O.	Position of Upon Clearness Level	Exposure Time					
		a	*b*	*c*	*d*	*e*	*f*
W....	Left.....	1%		1%		2%	
	Center.....	7%	8%	6%	5%	5%	7%
	Right.....	7%	8%	8%	8%	7%	6%
	Ends.....	3%	4%	3%	3%	1%	
F....	Left.....	3.4%		3.4%			
	Center.....	13.9%	24.1%	10.3%	13.9%	13.9%	10.3%
	Right.....	3.4%			3.4%		
	Ends.....						
D....	Left.....	8.8%	8.8%	10.1%	10.1%	10.1%	7.6%
	Center.....	10.1%	6.3%	2.5%	5.0%	3.8%	3.8%
	Right.....	2.5%	2.5%	1.3%			
	Ends.....	1.3%		2.5%		1.3%	2.5%

6. *Complexity of Material.*—Complexity of material, as well as length of exposure, seems to condition the dual-level reports. As Table IV. above shows, 'one-level' reports are more frequently given with the cards of Series I than with those of Series II. Furthermore, the reports of the dual-level type are more frequently given for the cards of Series II than for those of Series I. Nevertheless, complexity of material does not seem to be a condition of clearness in the dual-level reports; for the positions of the upper clearness levels are very nearly the same for both types of material.

Summary.—From the facts presented it is apparent that the conditions of clearness in this experiment are position fixation, predisposition, and quality. The first one of these, position, can be explained in terms of the other three. Length of exposure and complexity of material are conditions of the dual-level reports, that is, of the range of the upper level, but are not conditions of clearness itself. If the exposure is very rapid, if the material is very complex, some processes will necessarily be obscure, and others, depending upon the conditions named above, will be clear.

E. CONDITIONS OF COGNITION

In this experiment, beside the image of memory, the principal basis of the descriptions is the memory after-image. Evidence is furnished by the following introspections:

W (10) "Both of the colors persisted in and were described from the memory after-image"; (49) "Cognized after exposure from the memory after-image and the memory image"; (68) "I describe accurately and easily from memory after-image or from image of memory"; (150) "The colors are undoubtedly noted, apperceived, cognized, apprehended as objects, as 'reds,' 'blues,' etc.; there is no awareness of attributes during exposure. After exposure I can hold the 'object' in memory after-image or memory, and by taking successively the hue, tint, and chroma attitudes, I can describe it." (166) "I now feel fairly certain that cognition during exposure is either 'that is familiar' or 'I know what it is.' Both approximate to the direct apprehension which is the ultimate stage of recognition. I have reported many times that colors are never named until after exposure."

F (61) "More and more naming seems to me to be done after exposure and dependent upon the memory after-image to a great extent." (63) "Impressions persist for a brief period after exposure as positive or memory after-image and during that time I name them (aud.-kin. verbal) and write them down. Then I try to characterize or further describe them. During this time some individual colors come up in images of the sort I think Meumann calls 'primary memory.' Here some colors come up full and complete and with a feeling of familiarity and assurance. They look as they do in a true memory after-image. Others refuse to come up in image at all, or come up as 'habitual images' with a feeling of helpfulness or uncertainty"; (241) "Trying to see if I can tell whether the persistence of the impressions after exposure is a positive or a memory after-image, which I haven't been sure about. This time I turned my eyes away (towards the paper as quickly as I could after the exposure and before naming colors). It is hard to do; I wanted to keep looking in the original direction. Even after I looked away the colors seemed localized in the original position. My best judgment therefore is that the fundamental image, with the sensations the chief basis of my naming and describing, is a memory after-image"; (242) "No doubt about it, the colors stayed

a long time in the original position when I turned my eyes away; it is a memory after-image."

D (9) "Named from the memory after-image"; (17) "The colors were named from memory after-image"; (19) "Named from memory, lost the memory after-image, have feeling of uncertainty about the color qualities named"; (31) "Never name the colors during the exposure, all that comes after. Immediately after the exposure I name verbally from memory after-image"; (63) "Immediately after exposure name (verbal-kinæsthetically) from memory after-image." (179) "During the exposure I merely receive the impressions; immediately after, I cognize the colors, mainly from memory after-image"; (235) "Whenever the memory after-images disappear I am unable to continue the naming, though I am still able to report from memory that there were a certain definite number of qualities that I didn't name."

Cognition is therefore dependent upon the clearness, strength, quality and duration of the memory images, that is, upon the conditions of impression and retention; and upon practice, direction of effort, order of report, ease and facility with which the verbal associations necessary for report arise; that is, upon the conditions of reproduction.

The conditions of impression which act as determinants of cognition in this experiment are:

1. *Clearness.*—As we have mentioned above (pp. 18 f.) and as is shown in Table II., attributive clearness is one of the conditioning factors in the perception. When the dual-level type of consciousness is reported, the processes at the upper level of clearness are cognized at a high perceptual step; and conversely the processes at the lower level are usually cognized at a low perceptual step. The statement regarding the lower level is qualified by 'usually' because the results show that obscurity is not always paralleled by a low degree of cognition. There are certain conditions, as we shall see, which cut across clearness, and which make for cognition even though the processes have been obscurely experienced.

2. *Position.*—The per cent. of times that hue was cognized at different parts of the exposure card is shown for every one

of the 240 experiments in Table XIV. No position for W has a great superiority; what advantage exists, however,

TABLE XIV

SHOWING THE PER CENT. OF TIMES THAT THE HUE OF THE VARIOUS POSITIONS OF THE EXPOSURE CARD WAS COGNIZED

O.	Position Cognized			
	Left	Center	Right	Ends
W.....	33%	25%	35%	7%
F.....	35%	54%	11%	
D.....	71%	22%	2%	5%

lies in favor of the right, the same area which we found in the dual-level reports to be most frequently in the upper clearness level. The central position for F and the position at the left for D possess as great an advantage for cognition as they proved to possess for clearness.

3. *Fixation.*—In confirmation of Britz[1] we found that fixation is a condition of cognition. F and D reported their fixations in 178 and 143 cases respectively. The number of times that the different areas were cognized with the various fixations is shown in Table XV. The results of F sustain

TABLE XV

CORRELATION OF AREAS COGNIZED WITH THE POINT OF FIXATION

O.	Fixation	Position Cognized				Number Cases
		Left	Center	Right	Ends	
F.....	Left.....	1.8%				
	Center....	28.1%	58.0%	9.5%		178
	Right.....	.6%		1.8%		
D....	Left.....	2.8%				
	Center....	61.6%	26.5%	2.0%	5.5%	143
	Right.....	.7%				

"Number Cases" shows the number in which the fixation was reported.

Britz: fixation at the left is paralleled by cognition at the left; at the center, by cognition at the center; and at the, right, by cognition at the right. The results of D, however

[1] *Op. cit.*, 63. We also add that the exposure field lay well within the zone of clearest vision. Physiological factors, therefore, need not here be considered.

TABLE XVI

QUALITIES REPORTED FOR THE VARIOUS STIMULI

Qualities Reported	Observer																																	
	W.											F.											D.											
	Color of Stimulus										Total	Color of Stimulus									Total	Color of Stimulus									Total		
	R_1	R_2	O	Y	G	B	V	P	Gy	Bk		R_1	R_2	O	Y	G	B	V	P	Gy	Bk		R_1	R_2	O	Y	G	B	V	P	Gy	Bk		
Red 1	*52*	8	17				1	7	2		87	*75*	14	18			3	1	10	2		123	*63*	7	13	1	17		3	9	9	2	114	
Red 2	1	*15*									16		*10*									10		*25*	1		5		2	3			36	
Orange	1	6	*58*	1							66	5	11	*73*			1		3	2		95	2	7	*38*		1	17			3	4		72	
Yellow		1	3	*97*	2						103	2	4	7	*110*	2		2	1		1	129			30	*112*	6						148	
Yellowish		2											1										1	2	5		2							
Tan																							1	3										
Brown																							2	2		1				2	1	5		
Yellow green														1	4	4							1		2									
Green	1	1			*70*			1			73	1	2	2		*85*			2	1		93	1	4	1		*8*						14	
Blue green																		2	1															
Blue						*92*	30	6	4	2	134	4	4	5		4	*98*	80	11	18	6	230					1	*111*		51	16	3	9	191	
Light blue						1	2		1						1													3	36	7	3			
Violet			1			5	*25*				31	1		2		1		*3*	7	1	3	18								*1*			1	
Purple	5	12	2	1			1	*50*		1	72	9	52	1	1	2	2	1	*59*	3		130	6	2			3	2	2	*25*	10		50	
Gray		1							*20*		21	3	4	1		1	1	3	1	*65*	4	83	2	5			1		2	2	*21*		33	
Light		1												1	3			1						6	2		6			2	1	5		
Dark	1					1			1	2		1				1	3	1	3	3	1		2	2	1			6	3	7	5	4		
Black	1								11	*72*	84	3		1			2		3	3	*90*	102	2						11		*97*	110	
No quality reported	70	85	51	33	60	33	73	68	93	55	621	28	30	20	13	31	23	36	31	34	27	273	49	67	39	12	66	10	30	46	70	15	404	
Times correctly cognized	52	15	58	97	70	92	25	50	20	72	551	75	10	73	110	85	98	3	59	65	90	668	63	25	38	112	8	111	1	25	21	97	501	
Times incorrectly cognized	10	32	23	2	2	7	34	14	19	5	148	29	92	39	9	16	11	93	42	33	15	379	20	40	55	8	58	11	101	61	41	20	415	

point less obviously to this conclusion. He seems, no matter what the fixation, to be predisposed toward the left. Nevertheless we regard his results as confirmatory. In view of his disposition, a condition which we shall later consider, the only explanation for the large per cent. cognized at the center is fixation.

4. *Quality.*—The qualities reported for the various stimuli are shown in detail for every observer in Table XVI. The stimuli are placed at the head of the table. The figures below, which appear opposite the colors listed at the left under the caption "Quality reported," indicate the number of times the stimuli were cognized as of those qualities. The figures in *italics* show the number of times the stimuli were correctly cognized. Opposite the legend "No quality reported" appears the number of times that the stimuli were not cognized. At the foot of the table a summary is made of

TABLE XVII

RANK-ORDER OF THE COLORS CLASSIFIED ACCORDING TO THE FREQUENCY THAT THEY WERE COGNIZED, THAT THEY WERE CORRECTLY COGNIZED, AND THAT THEY WERE INCORRECTLY COGNIZED

O.	Rank Order									
	1	2	3	4	5	6	7	8	9	10
W.....	*Y*	*B*	*Bk*	*G*	R_1	*O*	*Gy*	*P*	R_2	*V*
F.....	*Y*	*B*	*Bk*	*G*	*O*	R_1	*P*	*V*	*Gy*	R_2
D.....	*Y*	*B*	*Bk*	R_1	*O*	R_2	*P*	*Gy*	*G*	*V*

the number of times that the stimuli were correctly and incorrectly cognized. For example, W cognized the saturated red stimulus, R_1, 52 times as red, once as light red, once as orange, once as green, 5 times as purple, once as dark, and once as black; 70 times he failed to cognize it; 52 times he cognized it correctly; and 10 times he cognized it incorrectly. An examination of this Table reveals that some stimuli were cognized more frequently than others (as measured inversely by the number of times that no quality was reported); that some were cognized correctly more often than others; and that some were cognized incorrectly more often than others.

The rank-order of the colors, figured upon this threefold basis, is given in Table XVII.

This table clearly shows that quality is a condition of cognition. Some qualities, *Y*, *B*, and *Bk*, are uniformly ranked at the head of the list, while others, *V*, *Gy*, and *P*, are as consistently at the lower end.

The conditions that we have thus far considered are, we believe, effective for cognition only in so far as they are effective for clearness. We now return to conditions which are effective for cognition alone.

5. *Length of Exposure.*—As is shown by the data of table XVIII., fewer colors were named after the short exposures than after the exposures of medium length, and fewer were named after the exposures of medium length than after the exposures of the longer durations. The difference is small, but is constant for all the observers. We conclude that cognition is conditioned by, and varies directly as, the length of the exposure.

TABLE XVIII

AVERAGE NUMBER OF 'COLORS' COGNIZED AT EVERY EXPOSURE TIME

O.	Exposure Time						
	a	*b*	*c*	*d*	*e*	*f*	Total
W.....	2.40±.54	2.60±.49	2.95±.28	3.00±.45	3.20±.59	3.15±.65	2.9±.52
F.....	4.17±.66	4.27±.65	4.45±.68	4.50±.65	4.62±.72	4.52±.70	4.4±.69
D.....	3.20±.84	3.45±.87	3.62±.71	3.70±.64	3.80±.76	3.90±.76	3.6±.82

6. *Color Sensitivity.*—Observers W and F have normal color-vision, and their records do not reveal any anomalies of color cognition. The reports of D, who was known beforehand to be partially color-blind, show marked irregularities of this kind. D seems, as shown in Tables XVI and XVII, to be incapable of cognizing green. He fails to perceive a quality, when the green stimulus is exposed, in exactly half of the cases, 66 out of 132; and when the stimulus is perceived, it is cognized as red or orange in nearly two thirds of the cases.[1]

The conditions affecting retention which act as determinants of cognition are:

[1] D cognized the red stimuli correctly more frequently than did either of the other observers, and his errors were relatively not greater.

7. *Complexity of Material.*—The number of times that one, two, three, four, five, and (for cards of Series II) six colors were cognized appears below in Table XIX.

TABLE XIX

NUMBER OF QUALITIES COGNIZED PER EXPOSURE CARD FOR THE TWO SERIES OF EXPOSURE MATERIAL

O.	Series	Number Cognized						Average and M. V.
		1	2	3	4	5	6	
W....	I.....	1	31	68	16	4		2.9±.51
	II.....	2	31	65	21	1	0	2.9±.53
F.....	I.....	0	1	7	25	87		4.6±.48
	II.....	0	4	27	52	30	7	4.1±.72
D....	I.....	2	7	41	44	26		3.7±.77
	II.....	1	16	36	54	13	0	3.5±.76

An inspection of these data reveals that complexity of material had but little if any effect upon W. His range of cognition in both series of exposure cards was about 3 colors, and the distribution of his reports was approximately the same in both series. What little difference exists, however, as is shown by the m.v., lies in favor of the simpler materials. This relation is more clearly shown in the results of F and D. These observers report the higher ranges more frequently and on the average cognize more colors when the cards of Series I. were used. Greater opportunity for cognition is more than outweighed by the disadvantage of greater complexity.

F's introspections bear out his results: (155) "The big outstanding difference between experiments is 5 colors *vs.* more than 5; easy *vs.* hard colors to name"; (64) "When 6 or more colors are exposed there is a 'blank' immediately after exposure. I do not start to name them nearly so quickly as when only 5 are exposed. It is as if I were helpless or had to set myself a new task, whereas in the exposure of 5 colors I go straight ahead naming after exposure. The memory after-image of 5 colors seems to take care of itself (usually all 5 persist), whereas with 6 or more colors only a few appear in memory after-image."

(8) *Duration of the Memory Image.*—The longer the duration of the memory images, the more colors were cognized, and the more complete were the qualitative descriptions. The duration is dependent upon the conditions which we have just considered and also, as was frequently reported by F and D, upon a condition which very much resembles retroactive inhibition. Immediate activity tends to destroy the memory images.

F (48) "Naming is not an absolutely immediate process but one which interferes with the memory images"; (49) "Five colors only, all on upper level; naming them drove the memory after-image out of mind, so I cannot give a description of them"; (76) "Naming drove the other colors out of mind as colors"; (100) "About 7 colors; the trouble was that I couldn't name them fast enough and that naming some drove others out of mind."

D (8) "Knew all the qualities immediately after the exposure. If I could have set them down with one stroke of the pen could, I am quite sure, have reproduced them all. I started to name from the left, and before I had reported the third I had lost memory of the series"; (13) "Turned immediately after the exposure to report. This activity dispersed the memory images"; (113) "Could name all the colors immediately after exposure, they were all familiar, but when I turned to set them down in my report lost my knowledge of them."

The conditions of reproduction which act as determinants of cognition are:

(9) *Practice.*—For the purpose of discovering the effect of practice the experiment was divided into thirds, and the average number of colors named by the observers was calculated for every one of these periods. The results are shown in Table XX. After an initial improvement there is an actual decrease in the average number of colors named. Both the improvement and the decrease, as the experiments upon apprehension have shown, may be explained by habituation to the experimental requirements, by the development of tricks and schemes of grouping and reporting, by ennui and

lack of interest. In so far as these factors are inherent in practice, practice is a condition of cognition.

TABLE XX

AVERAGE NUMBER OF COLORS REPORTED FOR THE THREE PERIODS OF THE EXPERIMENT

O.	Division of the Experiment		
	1	2	3
W	2.80±.60	3.01±.39	2.92±.50
F	4.11±.73	4.72±.68	4.26±.63
D	3.52±.74	4.00±.71	3.91±.75

(10) *Direction of Effort.*—When the observers make an effort to recognize and name the colors the task is more adequately performed, more colors are named, and higher perceptual steps are reported than when he 'sets' himself to the description of process. Following are examples:

F (5) "I was set for color." (All the colors were named, 5.) (33) "Set myself hard to get all the colors I could." (All colors named, 6.) (242) "Set myself to name and describe all the colors I could, trusting to luck for introspection. I can't report adequately on clearness with this set." (All the colors named, 5.) (33) "Didn't set myself for as many as possible this time, having realized that I am not quite obeying directions when I put so much emphasis on naming, so set myself to follow directions." (Four colors named, Series I.) (241) "Gave my full attention to the report of process." (Two colors named, Series II.)

W (54) "I find that I am trying to name more colors." (Named three, Series II.) (146) "I was set to name, and the names were touched off by the exposure." (Named four colors, Series I.) (93) "Reported the clearness and duration of the processes, then turned to name the colors and could name but two." (A card of Series II employed.)

D (63) "Set for hue." (Named five colors, Series I.) (49) "Resolved before the experiment to get all the colors, was determined." (Named them all, Series I.) (30) "Able to name only two qualities." (Began his report with a description of process; a card from Series II. employed.)

(11) *Order of Report.*—As has been mentioned, the effect of fixation was almost obscured in D's case by his disposition to name the colors from left to right as in the manner of reading. This tendency would, of course, place the right end and a part of the middle at a disadvantage. F's disposition to report from the center, first from the center left, and then from the center right, would place the center and the left at a great advantage and impair the cognition of the right end. W was disposed to name from the right to the left, and in most of the experiments he did so; but, as is shown above in Table IX., he began his reports in the greater per cent. of cases from two points: from the right end in which case the right would possess an advantage; and from the center, in which case, since his range of cognition was about three (Table XVIII.), the left would possess an advantage. Since the center in both cases would not suffer the same impairment as the opposite end, we should expect to find the various areas of the exposure card about equally well cognized.

That a disposition toward a definite order of report is a condition of cognition is shown by our results; for the positions cognized (Table XIV.) closely correspond to these predictions. Britz also noticed this condition.[1]

12. *Association.*—Cognition is dependent also upon the freedom and ease with which associations arise. Not only do the objective results give evidence of this effect, but one of the observers also corroborates it in his reports: "Cognition depends very much upon the ease of naming, *i.e.*, the facility of the association of verbal images with the sensed qualities" (D 17). At times the associations facilitate one another and the naming goes easily. Examples are:

W (186) "Easily named, cognized during exposure as familiar."

F (147) "The names came easily."

D (8) "Familiar colors, knew all of them at exposure."

At other times the associations inhibit one another, the observers suffer a kind of mental block, something akin to

[1] *Op. cit.*, 63.

terminal inhibition, and the processes of cognition are interrupted. The reports are affected by this in various ways:

1. Only those qualities are reported that have been cognized up to the moment of 'block'; examples are:

W (68) (Named two colors, was inhibited by the third) "Hesitated at pink, I think the struggle for this name drove the others out of memory."

F (96) "Gray, red, ——, disturbed by trying to name color to left of red, couldn't get name."

D (147) "Named the colors easily until I came to third, which I cognized as white. Considerably disturbed, for I knew there wasn't such a quality in the series; feeling of surprise and bewilderment which persisted and interfered with the cognition of the rest of the series."

2. The habitual order of naming is changed; examples are:

F (144) *O* began his report in his usual manner, naming from center to left, met a 'difficult' color, and then without hesitation proceeded to the cognition of the colors to the right; "Blue at center, some color which I can't name at left, reddish orange to right of center, and yellow to right of it."

D (100) "The qualities at 1 and 2 'difficult,' so named in reverse order from right, for I have learned if I hesitate in the naming I shall name but few."

3. The meaning is carried in other terms and the colors are correctly named in the report; examples are:

W (57) "The violet was noted first and called *B*, renamed in report as violet"; (88) "Both *O* and *P* were first cognized as red, correction made in report. The cognitive confusion is very hard to describe; I cannot say how the meaning of *R* carried the *O* character of the *O* impression; there was a feel of "not red" and this feel attached itself also to the *P*. I think there is also a feel of strangeness about the *P*, as if to say 'You can't be *R*,' then 'purple' came verbally with feeling of relaxation."

D (93) "Second color salmon, I carried it by word 'something'"; (104) "Named 'red' but all the time meant *P*, that is, I gave one name and meant another. The wrong name seemed to carry the meaning as well as the correct, for

when I came to report I made correction without hesitation"; (156) "The meaning of O and P was carried in an organic glow"; (170) "Coudn't get name for quality at 1, called it 'blue' and went on. This *plus* a mass of organics gave me O for the report"; (233) (Named all five of the colors.) "Did not hesitate over the ones I coudln't immediately name, called them 'um' and passed on as: 'um-black-um-blue-yellow." (In the report the 'ums' were recorded respectively as *R* and *O*.)

4. The number cognized is curtailed; examples are:

F (84) "All five of the colors on upper level, but names didn't come quickly enough, and besides I hesitated over V (which was second one named), so there was nothing to name when I came to end of series." (Named three colors of card of Series I.) (168) "Delayed too long on naming P to get the rest well"; (174) "Words wouldn't come as I tried to name, and I lost memory of most of the colors before I succeeded in getting names."

5. The quality that causes the inhibition is omitted; examples are:

F (127) "The first color did not name easily so I skipped it." D (9) "Couldn't cognize 2, so skipped it and continued naming"; (77) "Couldn't get a name for 4, so passed on to 5, so as not to lose it by hesitating over 4."

Summary.—The conditions of cognition which obtain in this experiment are clearness, and all the determinants of clearness—position, fixation, quality and order of report; length of exposure; color sensitivity; complexity of the material; the duration of the memory image; practice; direction of effort; and the facility of verbal association. These conditions are effective in the impression, the retention, or the reproduction.

F. Corollaries

1. *Levels of Attention.*—Our first corollary is a confirmation of the dual-level formation of the attentive consciousness. F and D reported the two-level formation, a clear focus and an obscure background, throughout. Their reports merely corroborate the findings in other experiments regarding the

dual-level type.[1] W, however, reported the multilevel formation, and we at first thought that we had in his case confirmatory evidence of the existence of this type. He reported the formation 5 times, 3 times within the first 12 experiments, the fourth time in the 29th, and the last time in the 118th experiment. The first and second times he expresses no uncertainty about the report: (3) "Describing from right to left, green, yellowish, good chroma, medium tint; blue, orange, can't describe them further; others there but I cannot name them. Green was most clear, at upper level; blue and orange next, of medium clearness; others obscure, at lower level." The third time he was uncertain": . . . the others seemed to be at a third level of clearness. I say 'seemed to be' for I am not sure, but think the memory after-image and report cut across the experience." The fourth time, in the 29th experiment, he was even more uncertain: "Whether they are levels in cognition or clearness I cannot say; I have as yet found no criteria for judgment." By the 118th experiment he had gained these criteria, and was able to say that the multilevel formation that he had reported did not mark sensory levels of clearness but degrees of cognition. We quote this report in full: "Green, yellowish, good chroma, medium to light tint. Orange, reddish, good chroma, medium tint. A number of others, perhaps 4, some of them I am sure were colored. Green first caught attention, then the orange. Some of the others were clear, but I do not know what they were. Still others were there and they seemed to be at a still lower level. There thus seemed to be three groups, (1) those I named, (2) those I could almost name, (3) those that were simply there as meaningless impressions. I cannot say even whether they were 'bunte Farben' or greys. My impression is that (1) and (2) were about equal in attributive clearness, on the upper level, and (3) much lower in clearness, on the lower level. This is what I have before reported as the multilevel type." Though similar occasions again occurred in which the cognitive degrees stood thus apart, he

[1] K. M. Dallenbach, *Am. J. of Psych.*, XXIV., 1913, 506–7. E. E. Cassel and K. M. Dallenbach, *ibid.*, XXIX., 1918, 207.

thereafter reported nothing but the dual-level type. If then our study had ended with the 117th experiment, we should have concluded that W belongs to the multilevel type. His subsequent analysis and reduction show that he is, in fact, of the dual-level type, and lead us to raise anew the question whether there are ever more than two degrees of clearness observable in the processes of a given consciousness.[1]

2. *Minor differences of sensory clearness* were very frequently reported by our observers in the upper level, but were not noted in the lower. The following introspections are typical. W (141) "Field as a whole clear. The black and blue stood out momentarily above the others. This is the 'wrinkle' pattern." W (142) "Green caught attention

[1] Three cases of the multilevel type have been reported in the experimental literature. We proceed to examine them. (1) W. Wirth (*Phil. Stud.*, XX., 1902, 493 f.) found under certain conditions that there were more than two levels of clearness in his own consciousness. He maintains that at any moment of attention all possible degrees of apperception may be represented. A reexamination of Wirth's work, in the light of our results, shows unmistakably that he was judging and reporting cognitive clearness. All possible degrees of cognitive clearness, to be sure, may exist in a given consciousness. (2), (3) L. R. Geissler, in his work on the measurement of attention (*Am. J. of Psych.*, XX., 1909, 527 f.), reports two cases of the multilevel type. As he himself recognizes and points out (p. 527), his experiments dealt not with a simultaneous but with a successive consciousness. They lasted, for his observer B, from 15 to 22 seconds (p. 518), and for his observer C, 12 seconds (p. 517). Consequently the reports may have been either temporal accounts or, if viewed as a whole, general averages. The introspections that Geissler offers in confirmation of this type are so abridged that it is difficult to reconstruct the consciousness that lay behind them. It is to be regretted that he does not quote in full the introspective replies to the questionary (p. 519) answered at the end of every experiment. The answer concerning the temporal relations would have an important bearing upon this subject. It is a fair inference from the few passages quoted that observer B was giving a temporal account of the clearness variations; for in none of the examples does B say that all the levels described occurred simultaneously. C obviously reported general averages. Whether the levels that she mentions occurred simultaneously or successively she does not say; but the point in her case is irrelevant; for it is plain from her account of her criteria of clearness that she was judging cognitive clearness throughout. She says that her judgment of clearness "is a matter of clearness in memory; if the circles stand out plainly in memory I put them high in the scale, if not I put them low" (p. 521). Again, B observed in 30 experiments, and C in 130. Geissler does not state how many reports of the multilevel type each observer gave, nor how they were distributed throughout the total number: whether they were more frequent in the early experiments than in the late, were grouped toward the end of the series, or were more or less evenly distributed. These considerations, as our work with W shows, are of great importance. The existence of the type is not proved by Geissler's evidence.

and held it throughout, the orange certainly was as clear, but do not think that the purple and yellow although in the same level were as clear. The others were at a very low level." F (140) "Five colors, . . . all on upper level, but last two not so clear as first three." (9) "Five impressions, three center rectangles with long axis vertical, blue, red, green, . . . cannot name the other two. Impressions of blue were clearest, but all named on upper level; others obscure."

These results corroborate Titchener.[1] He observed the clearness 'wrinkles' in the processes at the upper level, and likewise failed to note them in the lower. There is, of course, no reason *a priori* why there should not be differences of clearness, or rather of obscurity, at the lower level as well as of clearness at the upper level; the range and number of degrees of cognitive clearness in the lower level (of the dual-level reports, Table II.) far exceed the range and number in the upper level. It may possibly be, as Titchener says, that under very favorable conditions these variations would be observed.[2] Under our conditions, however, they were not found. So we conclude with Titchener, "that—whatever the case at the lower level—there are noticeable differences of clearness in the processes at the upper level of consciousness." [3]

3. *Range of Attention.*—In experiments on the range of attention, range has always been determined by the number of objects—lines, letters, words, numbers, figures etc.—which can be named or reproduced after a momentary exposure; that is, by the number cognized. This procedure is justifiable on the assumption that all the impressions which appear at the upper level of clearness are cognized; and, conversely, that all the impressions cognized appear at the upper level. But our study has shown that neither of these assumptions are correct. All the attributively clear impressions were not cognized (note the number of times the impressions were at one level, Table IV., and the number of times 5 and 6 colors

[1] 'Feeling and Attention,' 1908, 230–242; *Psych. Review*, XXIV., 1917, 57.

[2] 'Feeling and Attention,' 232.

[3] *Op. cit.*, 238.

were cognized, Table XIX.); nor were the impressions which were cognized, since cognition is dependent upon many conditions besides attributive clearness, always in the upper level of clearness. Indeed, as we have shown above (Tables II. and III.), obscure processes were not infrequently cognized.

These experiments upon the range of attention therefore give us merely a range of cognition, and the statements in current textbooks that the 'grasp of visual attention covers from four to six simultaneously presented simple impressions' is a statement concerning visual apprehension, not attention.

IV. Summary of Results

The results of this study may be summarized as follows:

1. Britz's perceptual steps have been verified and his classification has been extended.

2. The complexity of the problem and the inherent difficulties of the method, which required both a report of meaning and an exhaustive description of process, are offered as a possible explanation of Britz's failure to obtain data regarding attributive clearness.

3. Our introspections have been classified upon the basis of sensory clearness. Four classes were obtained: (1) a group in which clearness was not mentioned; it was not under the conditions of the experiment reportable; (2) a group in which one level, the upper was reported; (3) a group in which two levels were reported; and (4) a group in which three levels were reported.

4. On the basis of the observers' reports the distinction between attributive and cognitive clearness has been confirmed: an impression may be attributively clear and cognitvely clear; attributively clear and cognitively unclear; attributively unclear and cognitively clear; attributively unclear and cognitively unclear.

5. The conditions of clearness which obtain in this experiment are: position, fixation, order of report, and quality. Length of exposure and complexity of material affect the range of clearness, but do not condition clearness itself.

6. The conditions of cognition are clearness and all the

conditions which make for clearness: position, fixation, order of report, and quality; length of exposure, color sensitivity, complexity of material, duration of memory image, practice, direction of effort, and facility of verbal association.

7. There are never more than two degrees of clearness observable in the processes of a given consciousness.

8. Minor differences of clearness, or 'wrinkles,' exist in the upper clearness-level.

9. The experiments hitherto made upon 'range of attention' are perceptual experiments, in which the end-result is the range, not of attention, but of cognition.

CURVES OF GROWTH OF INTELLIGENCE

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Up to the present time most investigations in the use of mental tests have been directed toward the practical value of such tests from the point of view of prognosticating the future behavior of individuals. Because of the comparative recency of the work in mental testing, there has been little opportunity to make systematic measurements of the intelligence of a number of individuals over a period of years. This type of research will undoubtedly give us the best knowledge of the growth of intelligence. In the meantime, however, we may endeavor to gain some knowledge of the growth curve from an examination of group tests given to a large number of children of various ages.

PART I

The purpose of the results here presented is to suggest a few possibilities of individual prognosis to be expected as soon as group tests can be refined to the point of being as accurate as the individual examinations used in the past. Simplification of methods of administering, scoring and evaluating tests to the point where any school teacher of average intelligence can accurately give, score, and statistically evaluate mental and educational group tests, will be a big advance in the direction of securing the masses of data so necessary for determining group norms.

Our results are based on the median mental ages of 1,987 children, tested on a series of six group tests.[1] Chronological-age-mental-age distributions for all school ages from six to

[1] Pintner, R., 'The Mental Survey,' New York, 1917, 116 pp.

thirteen were obtained. To secure additional accuracy, the mental ages were grouped in classes of one half year mental age. This distribution table is too extensive to print here and is also unnecessary for the discussion. The percentages

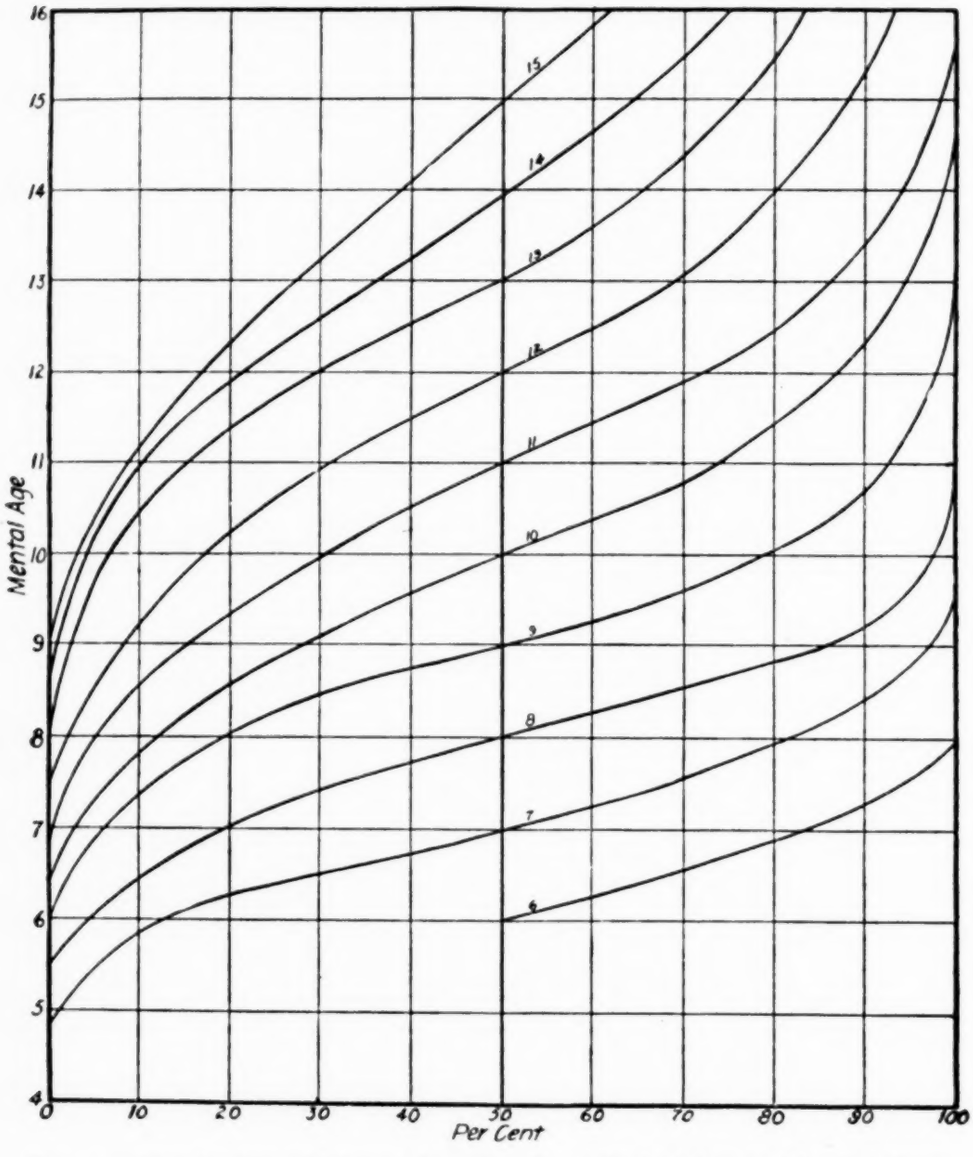

FIG. 1. Distribution of Mental Ages, by Chronological Age and by Per Cent.

derived from the table were turned into a cumulative distribution by chronological age and by mental age with the result as shown in Fig. 1. Very small irregularities have been ironed out of these curves by mechanically smoothing the curves in plotting. Each curve of Fig. 1 represents a

TABLE I

CHRONOLOGICAL AGE DISTRIBUTIONS OF THE MENTAL AGE LIMIT REACHED BY THE DESIGNATED PERCENTILE PERSON OF EACH CHRONOLOGICAL AGE GROUP

(Disregarding the sampling involved, and assuming constancy of percentile rank of the individual, the figures in the body of the table are ordinates for individual curves of growth of intelligence, as indicated.)

Percentile Person	Mental Age at the Chronological Age:									
	6	7	8	9	10	11	12	13	14	15[1]
Lowest....	—	4.8	5.5	6.0	6.45	6.8	7.5	8.0	8.65	8.95
5.....	—	5.45	6.05	6.9	7.3	8.0	8.55	9.70	10.15	10.45
10.....	—	5.85	6.45	7.35	7.8	8.55	9.2	10.45	10.95	11.15
15.....	—	6.1	6.75	7.75	8.25	8.95	9.8	10.95	11.5	11.8
20.....	—	6.25	7.0	8.05	8.55	9.35	10.25	11.35	11.85	12.3
25.....	—	6.4	7.25	8.3	8.85	9.7	10.6	11.7	12.25	12.8
30.....	—	6.5	7.4	8.45	9.1	10.0	10.9	12.0	12.6	13.25
35.....	—	6.6	7.55	8.65	9.3	10.25	11.2	12.3	12.9	13.7
40.....	—	6.7	7.7	8.7	9.55	10.5	11.45	12.55	13.25	14.1
45.....	—	6.85	7.9	8.85	9.75	10.8	11.75	12.8	13.6	14.55
50.....	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
55.....	6.15	7.1	8.15	9.15	10.2	11.25	12.25	13.3	14.3	15.4
60.....	6.25	7.25	8.35	9.3	10.35	11.45	12.5	13.6	14.6	15.8
65.....	6.45	7.4	8.4	9.45	10.55	11.7	12.75	14.0	15.05	—
70.....	6.55	7.55	8.55	9.6	10.8	11.9	13.05	14.4	15.5	—
75.....	6.7	7.75	8.65	9.8	11.1	12.15	13.45	14.9	16.0	—
80.....	6.9	7.95	8.80	10.55	11.4	12.45	14.0	15.45	—	—
85.....	7.1	8.15	8.95	10.3	11.85	12.9	14.55	—	—	—
90.....	7.3	8.4	9.20	10.7	12.35	13.4	15.3	—	—	—
95.....	7.6	8.8	9.65	11.4	13.15	14.2	—	—	—	—
Highest...	8.0	9.6	10.9	13.0	14.6	15.7	—	—	—	—

cumulative percentage distribution (ogive) of the mental age of all the cases of the chronological age designated on each curve. This chart was drawn to a very large scale, enabling accurate graphical interpolations to be made. The points of intersection of each chronological age curve and the respective percentage ordinates of Fig. 1 were thus graphically determined. Thus from the figure we can find the mental age equivalent of any percentile of any of the chronological ages. For example, the forty percentile eight year old has a mental age of 7.7, and so forth. The points of intersection, graphically determined, for every fifth percentile of all chronological ages are shown in Table I.

From Table I, we may plot directly percentile curves of growth of intelligence, chronological age being used as abscis-

[1] Age 16 not included. At most percentiles their M.A.'s are not as high as the 15-year-olds, due to mental retardation. They are also one to two years or more retarded in school.

sac, and mental age as ordinates. The result of such plotting is shown in Fig. 2, the circles representing plotting points. Only each ten-percentile curve is here shown. The plotting points are given for only five of the curves to prevent confusion.

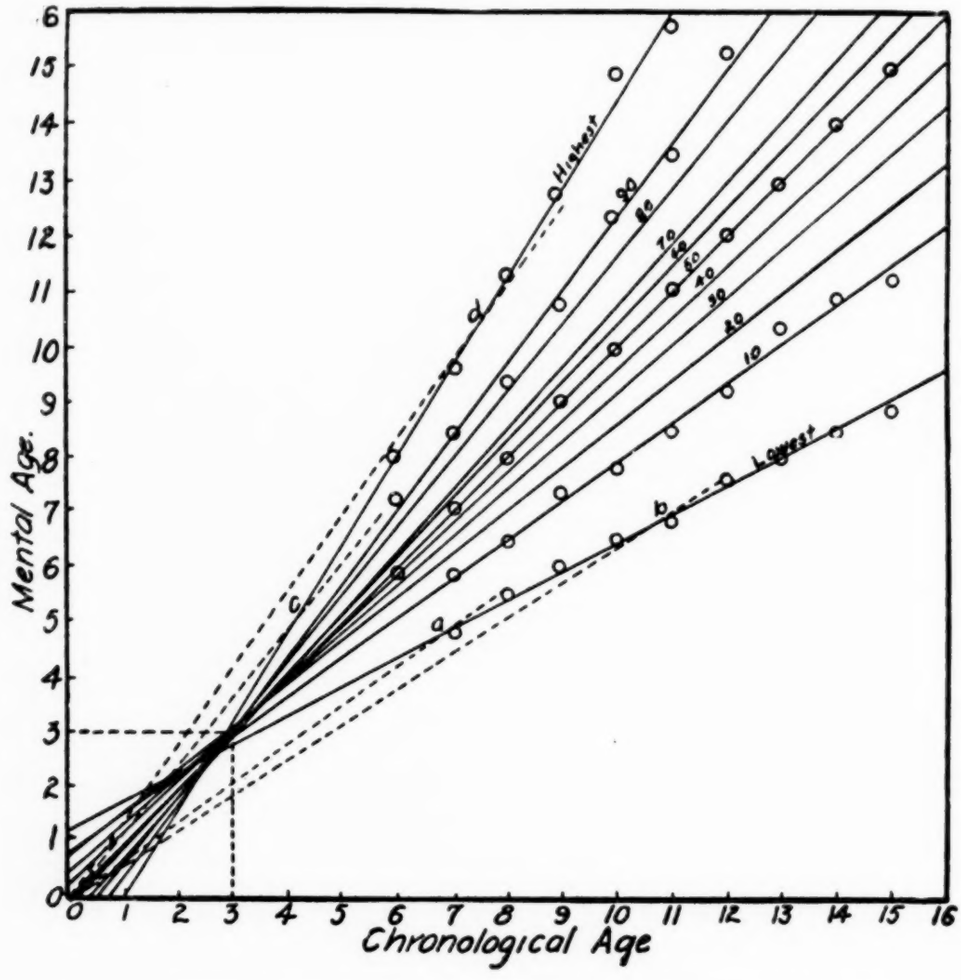

FIG. 2. Plotted Least Square Equations of Percentile Curves of Growth.

$$\text{Now the equation I.Q.} = \frac{\text{Mental Age}}{\text{Chronological Age}} \qquad (1)$$

may be written

$$M = \text{I.C.}, \qquad (2)$$

where M = mental age; I = I.Q.; and C = chronological age. This equation is a straight line. By the method of *least squares* the straight line equations of best fit of the actual percentile distributions have been calculated for each 10-

percentile and have been plotted on Fig. 2. The equations of these lines are shown in Table II. With the tests used, and with the distributions shown in Fig. 2, greater constancy of I.Q. on the whole would result from using the formula,

$$I = \frac{M - 3}{C - 3} \tag{3}$$

since the straight lines are seen to intersect at approximately $C = 3$, $M = 3$.

TABLE II

EQUATIONS OF LEAST SQUARE STRAIGHT LINES OF BEST FIT OF DATA OF TABLE I

$(M = I \cdot C + k)$

Percentile Curve	Straight Line Equation
Highest	$M = 1.589C - 1.536$
90	$M = 1.327C - .991$
80	$M = 1.213C - .587$
70	$M = 1.128C - .397$
60	$M = 1.057C - .150$
50	$M = 1.000C + .000$
40	$M = .931C + .261$
30	$M = .858C + .581$
20	$M = .784C + .813$
10	$M = .705C + .884$
Lowest	$M = .518C + 1.260$

Figure 2, although statistically correct, gives an entirely erroneous view of the probable actual differences in intelligence. None of these curves have any decided tendency towards becoming horizontal in the later chronological ages, indicating decrease in the rate of growth, as is known to be the case. We need a diagram, therefore, that will show the gradual decrease in the growth of intelligence with increasing chronological age. To obtain such curves we must obviously calculate the difference in amount of intelligence from one chronological age to the other. These amounts will determine the gradually decreasing distances for our mental age ordinates.

In Table III. are shown the standard deviation intervals between the median mental ages (half-year mental age classes) by chronological age. This table was constructed from the original frequency distribution table of mental ages by chrono-

TABLE III

STANDARD DEVIATION INTERVALS OF THE SEVERAL MENTAL AGES AS MEASURED BY THE SEVERAL CHRONLOGICAL AGE DISTRIBUTIONS

Chronological Age	Standard Intervals (Sigma)																		
	6.0–6.4	6.5–6.9	7.0–7.4	7.5–7.9	8.0–8.4	8.5–8.9	9.0–9.4	9.5–9.9	10.0–10.4	10.5–10.9	11.0–11.4	11.5–11.9	12.0–12.4	12.5–12.9	13.0–13.4	13.5–13.9	14.0–14.4	14.5–14.9	15.0–15.4	15.5–15.9
6	.54	.44	.59																
7	.97	.64	.38	.36	.46	.48													
8			.47	.48	.44	.64	.49	.35											
9			.53	.48	.36	.61	.34	.29	.45	.40									
10					.21	.40	.29	.22	.38	.26	.20	.24							
11							.25	.24	.33	.25	.26	.24	.35	.18					
12									.24	.26	.25	.21	.32	.19	.20	.15			
13											.16	.23	.33	.22	.25	.15	.20	.18	
14													.20	.27	.13	.19	.19	.16	
15															.25	.13	.30	.20	.12	.21
16																	.22	.24	.16	.06
Weighted Sigma Interval	.75	.54	.48	.43	.37	.55	.34	.27	.35	.29	.22	.23	.31	.21	.20	.16	.23	.19	.14	.13
Cumulative Sigma Interval	.75	1.29	1.77	2.20	2.57	3.12	3.46	3.73	4.08	4.37	4.59	4.82	5.13	5.34	5.54	5.70	5.93	6.12	6.26	6.39

logical ages. For each chronological age cumulative percentage frequencies for each mental age step in the table were calculated. The points represented by these cumulative percentages were then turned into sigma values by means of the usual table of values of the probability integral (Thorndike, 'Mental and Social Measurements,' Table 44). We thus have sigma values for each point on the table and the differences between these sigma values give us the sigma intervals shown in Table III. To make the matter still more concrete, we find from our frequency table that at chronological age six there are 36.8 per cent. who test at a mental age of 5.99 or below; 57.9 per cent. test at a mental age of 6.49 or below; 73.7 per cent. test at a mental age of 6.99 or below; 89.0 per cent. test at a mental age of 7.49 or below. These percentages are now turned by means of the integral table into the sigma values (*i.e.*, deviations from the median divided by sigma) $-.34$, $+.20$, $+.64$, $+1.23$. For example the 73.7 percentile is 23.7 per cent. above the median and we find from the table that a range from the median to $+.64$ sigma includes about 23.7 per cent. of the cases, and so with the others. Subtracting these values (*i.e.*, $-.34$ from $+.20$, $+.20$ from $+.64$, etc.) we get .54, .44, and .59 as standard deviation intervals for the three mental age intervals as shown in Table III. The figures give, for a normal frequency distribution of mental ages of children six years old chronologically, the distance or range on the base line (in terms of sigma) between the points 6.0 and 6.4 mental age, between 6.5 and 6.9 mental age, and so on. In a similar manner the standard deviation intervals for the other chronological ages have been computed. The table shows the general tendency of these standard deviation intervals, representing amounts of intelligence growth, to decrease gradually as we go from the lower to the higher ages.

In the table those standard deviations included within the blocked areas are direct measures of the interval, that is to say they are the chronological age distributions within one year of the mental age considered. Each standard deviation within the blocked areas was arbitrarily given a weight

of 3 and those figures of the table outside of the blocked areas were given a weight of 2 each and the average weighted intervals between the mental ages were thereby determined.

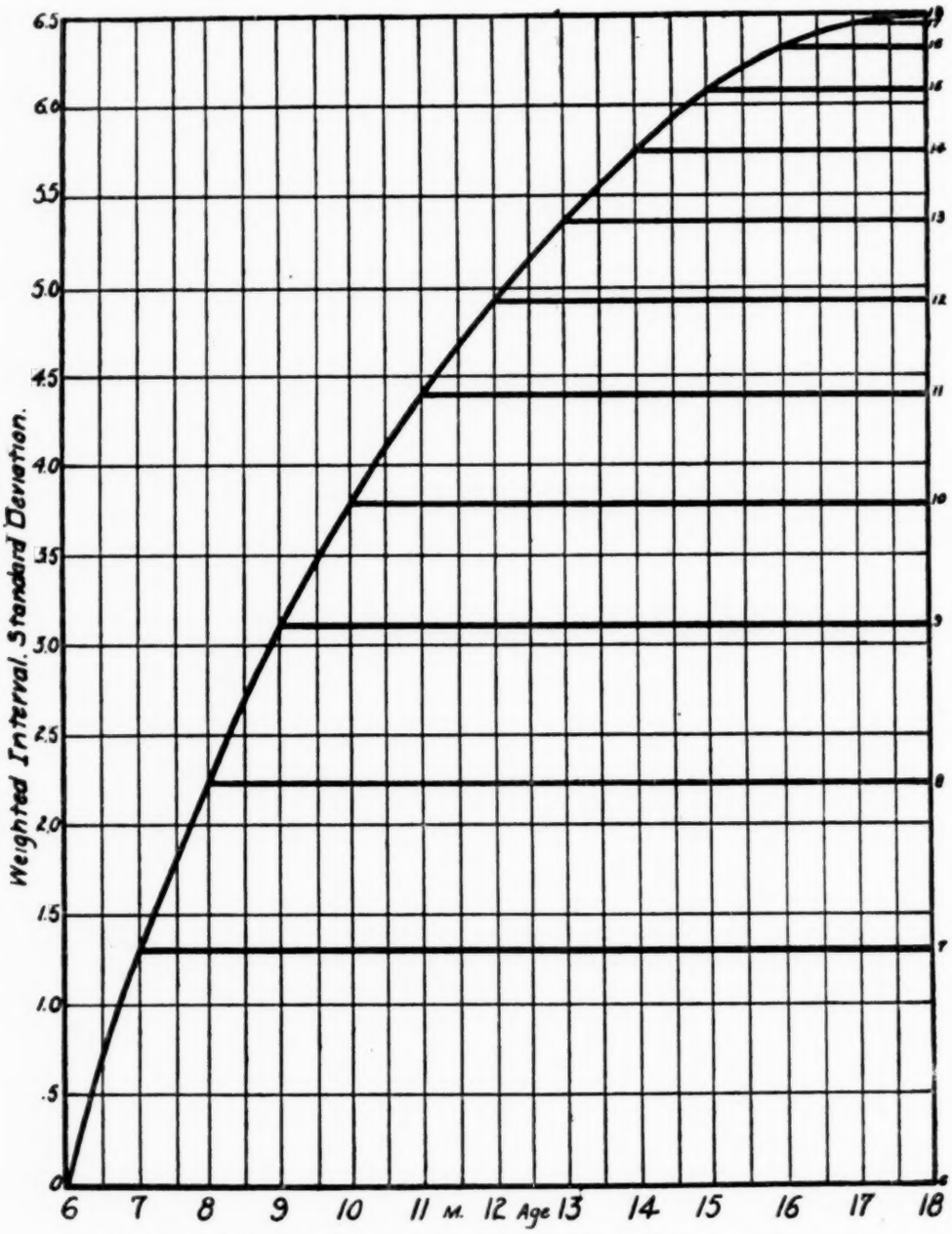

FIG. 3. Method of Determining M.A.-limits in Terms of Amount.

These weighted intervals are shown at the bottom of the table in the row called "Weighted Sigma Intervals." It will be noticed that there is a gradual decrease in the interval with increase in age but that these decreases are not perfectly

regular. To eliminate this feature, and secure a probably more accurate determination of the interval as well as having a high utilitarian value in plotting the curves, the mental age

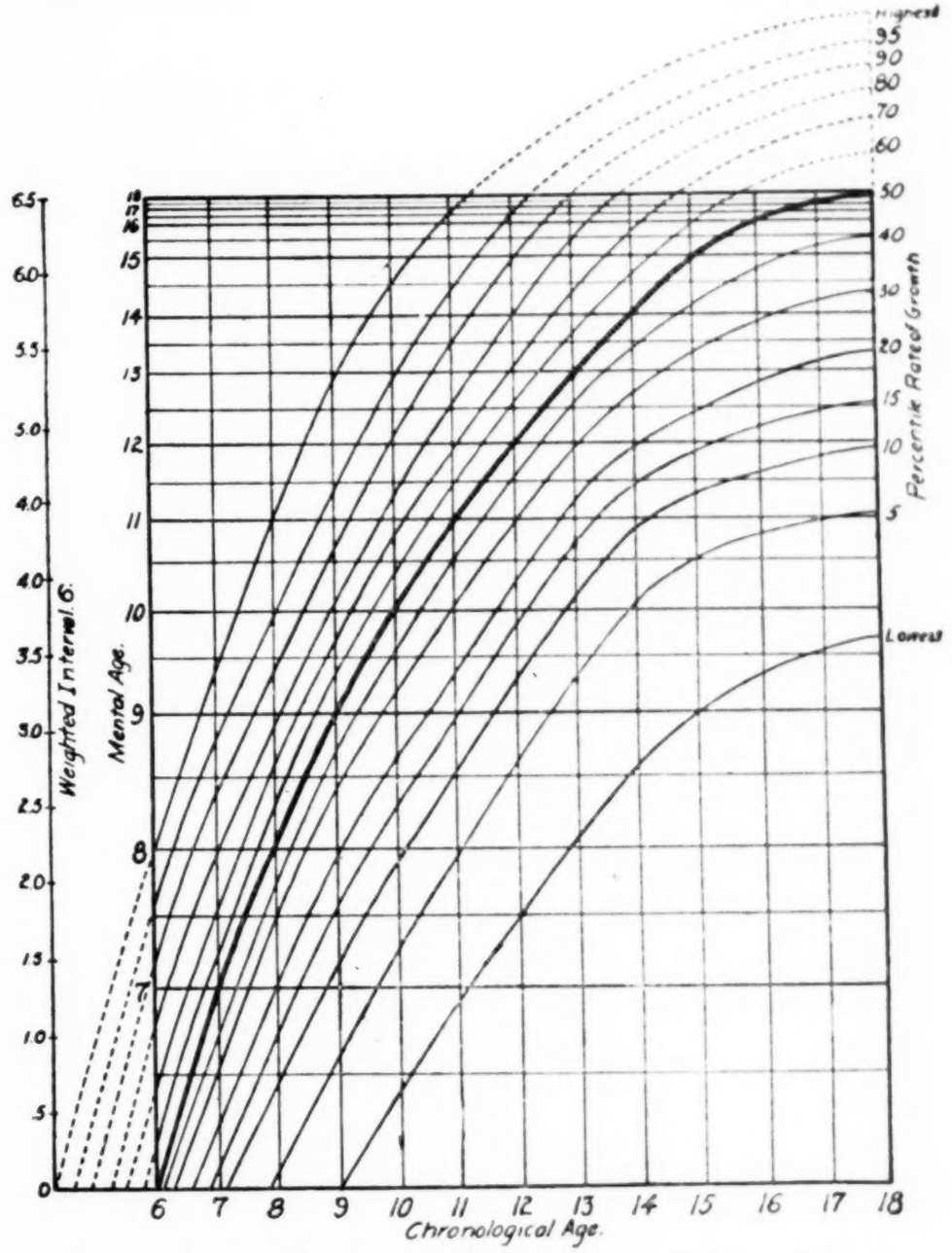

FIG. 4. Curves of Growth of Intelligence. Percentile Rates of Growth.

intervals were cumulated, as shown in the last row of Table II., and plotted as the curve of Fig. 3.

In this curve, very small irregularities were mechanically ironed out in drawing the curve. The intersections of each

mental age ordinate with the cumulative curve are projected to the right and form our foreshortened ordinates of Fig. 4.

Using these foreshortened mental age ordinates and the usual equal-interval chronological age abscissae, the data of Table I. were plotted with these coördinates. Due to the method of measurement of mentality in terms of mental age, mentality units above age sixteen are not available. The percentile curves have, however, been prolonged graphically until they come to a point where the rate of growth no longer increases. If we do this, we find that the median of the fifty percentile curve seems to stop at age eighteen. This is probably too high and due to the fact that the sampling of children in the higher ages was very likely more selected than those in the lower ages. As we know from other data, it is more likely that average mental growth ceases about age fourteen or fifteen. There may be some increase after these ages, but such increase is probably so slight as not to be measurable with the rough scales of intelligence that we possess at the present time. Our curves, therefore, based as they are upon the data derived from a specific set of tests, probably show too much increase in the higher ages, but they will serve, nevertheless, to indicate the general trend of mental development for all degrees of intelligence at the various chronological ages.

Part II

We must keep in mind the theoretical assumptions underlying the procedure in Part I. The assumption is made first of all, that intelligence tests of the type used actually do measure intelligence. No intelligence test has ever yet been devised which will give a perfect correlation with any independent social criterion of intelligence. Partial correlation may be used in combining mental tests with the proper theoretical weighting of each test to give the maximum correlation with any given social criterion. It is to be noted, however, that even the social criterion itself will never give a perfect correlation with the presumably true intelligence of the individuals involved.

The second assumption, which has often been used, but which has as yet not been put to experiment, is that the rth percentile child at any given chronological age will be the rth percentile child at any succeeding chronological age. If this be assumed to be true, then the use of the procedure outlined above is justifiable. If there are any "spurts" in intelligence, these would quite necessarily be covered up by the procedure used. Future measurements of the mentality of large groups of children over a period of years is very desirable in this connection. The assumption here made is purely arbitrary but consistent with the assumption ordinarily made by most experimenters in group testing.

The third assumption that the average weighted standard deviation is the best measure of mental age intervals is also purely arbitrary. A fourth assumption is that rates of growth of intelligence computed from mental tests of *school children* give the desired curves of growth. The statement often made to the effect that a distribution of *school children* is a representative sampling of the population as a whole is manifestly false; very apparently so, when one considers the very high amount of elimination from school in the higher grades. Such elimination in the seventh and eighth grades is largely of two kinds:

(*a*) Elimination of the mentally inferior, and

(*b*) Elimination by graduation of mentally advanced pupils who have also been advanced in school.

In point of numbers, (*a*) and (*b*) most certainly do not counterbalance each other. If we resort to the high school in order to secure a large number of persons of sixteen years or over, we again have a more decidedly selected group of people and not a *random selection* of test subjects at such ages. The difficulty of obtaining a *random selection* of test subjects at any age necessitates resorting to the schools for test subjects and such has been true in all investigations, at least so far as published. This will probably always continue to be the case. Curves of growth of intelligence based upon school children are decidedly not the best for purposes of prognosis.

Thorndike has clearly shown this fact in his investigation of school elimination.[1] Such curves are based upon the 'survivors' and the 'obtainable' and not on a random selection of the whole population of the chronological age limits considered.

[1] Thorndike, E. L., 'The Elimination of Pupils from School,' U. S. Bureau of Education Bulletin, No. 4, 1917, pp. 45–55.